NWT Greenhouse Gas Emissions Work Program

Final Report
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Submitted by

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1. Executive Summary

In order to develop the Strategy to control Greenhouse Gas (GHG) emissions in the Northwest Territories (NWT), a Working Committee has been struck under the authority of the Department of Resources, Wildlife and Economic Development. This working committee is using the information developed at the national level, and by other jurisdictions, to aid in the development of the NWT GHG Strategy that will ultimately be implemented by the GNWT.

Dillon Consulting Limited in association with Terriplan Consultants Ltd. and Lawson Environmental Services were retained by the working committee to assist in the development of background data that will be used in support and the development of the NWT GHG Strategy.

A series of possible initiatives were provided by the working group which were then screened by the consultants with the aid of several screening criteria. Based on the screening of the initiatives, the following groupings of the "achievable" priority items were developed.

Group 1 - Public Education and Outreach

2. Public Awareness/Education
3. Implement No Idling Policy
4. Preventative Maintenance
5. Introduce energy management into school curriculums or post secondary courses
6. Driver Reward programs
7. Vehicle Inspection and Maintenance
8. Increase telecommunications
9. Replacing Marine Services for Aviation kilometers traveled

Group 2 - Energy Management

10. Elimination of Territorial Energy Subsides
11. Development of NWT Emissions Reduction Energy Policy
12. Establishment of an Energy Retrofit Revolving Loan Fund
13. Adoption of Energy Efficient Codes for New Construction
14. Supporting NWT Municipalities
15. Public Awareness/Education Campaign
16. Development of Residual Heat Energy Technologies

Group 3 - Fundamental Shift in Energy Use

17. Renewable Energy Technology
18. Supply Clean Energy to mining industry
19. Replacement of diesel generators with systems that will significantly reduce levels of greenhouse gas emissions; development of hybrid generation systems; and promote the development and application of renewable energy technologies.

Each initiative was researched in the following areas:

1. Benefits
2. Emission Reductions
3. Implementation and Monitoring
4. Description of Costs
5. Cot Effectiveness
6. Sources of Uncertainty/Further Analysis

The results of the research is summarized in Table I.

Table I Summary of Proposed Initiatives

Initiative	*% reduction in GHG Emissions*	*Expected Life*	*Start up /Capital Costs*	*Operations l Costs*	*Capital cost/t CO_2*
Public Awareness/ Education	N/A	50 years	$75K	$25K	N/A
Implement No-Idling Policy	0.12% (1.8kt CO_2)	50 years	$0	$50K/ year	0$
Vehicle Inspection and Preventative Maintenance	0.37% (6.9 kt CO_2)	50 years	$50K	$25K	$6.9
Introduce Energy Management into School Curricula	0.19% (2 kt CO_2)	50 years	$2K/school	$30K/ year	$600
Driver Reward Programs	N/A	N/A	N/A	$20K/ year	N/A
Increase Telecommunication	0.49% (7 kt CO_2)	50 years	$100K	$700K/ year	$14
Replace Marine Services for Aviation Services	0.1% (1.6 kt CO_2)	50 years	$20K	$20K	$12.5
GROUP 1: TOTAL	**19.3 kt CO_2**	**50 years**	**$260K**	**$783K/ year**	
Elimination of Territorial Energy	N/A	50 years	$0	$32M total (see table	N/A

Initiative	*% reduction in GHG Emissions*	*Expected Life*	*Start up /Capital Costs*	*Operational Costs*	*Capital cost/t CO_2*
Subsidies				3.1)	
Development of NWT Emission Reduction Energy Policy	N/A	20 years		$150K (over 2 years, see table 3.1)	N/A
Establishment of an Energy Retrofit Revolving Loan Fund	30 kt CO_2	20 years	$1M	$0	$1.6
Adoption of Energy Efficient Codes for New Construction	N/A	50 years	$200K	$150K	N/A
Public Awareness and Education	N/A	50years	$0	$100K/ year	N/A
Support Municipalities	N/A	50 years	$0	$50K/year	N/A
Development of Residual Heat Energy Technologies	1.3 kt CO_2	50 years	$4M	User pay	$60
GROUP 2: TOTAL	**31.3 kt CO_2**	**50 years**	**$1.28M**	**$225K**	
Renewable Energy Technology	1% (14.3 kt CO_2)	50 years	$66.7M		$93
Supply Clean Energy to Mining Industry	7% (100 kt CO_2)	50 years	$50M		$1
Replace Diesel Generators with Systems that will Significantly Reduce GHG Emissions	7% (100 kt CO_2)	50 years	$4.9B		$98
GROUP 3: TOTAL	**214.3 kt CO_2**	**50 years**	**$5.0B**		

1.0 Introduction

1.1 General

Global climate change has, over the past decade, become a significant issue that has captured the attention of the world's nations. In 1998, Canada with many of the world's nations signed onto the Kyoto Protocol which calls for the reduction of Greenhouse Gas (GHG) emissions to pre-1990 levels by the year 2013. The Government of the Northwest Territories (GNWT), along with all of the other provincial and territorial jurisdictions, is participating in a national process to develop an implementation plan to meet the Kyoto Protocol objectives.

At the national level, several tables have been formed to develop background information, and to provide the background documentation for the development of the National GHG Strategy. Each provincial and territorial jurisdiction is working in parallel to the National Tables to develop the individual Strategies. The GNWT is part of the National Tables, and is also undertaking to develop a NWT GHG Strategy to address the commitments to the Kyoto Protocol.

Coupled with the desire to reduce the GHG emissions is the reality that the north is undergoing population growth above the national average. The NWT is on the verge of a potentially large growth in the economic sectors, particularly in the diamond mining and cutting industries as well as the oil and gas development and production industries. Primary resource development, which is the root of the potential future growth in the NWT, is typically a large energy consumer and therefore will result in the production of increasing GHG emissions.

To develop the Strategy to control GHG emissions in the Northwest Territories (NWT), a Working Committee has been struck under the authority of the Department of Resources, Wildlife and Economic Development. This working committee is using the information developed at the national level, and by other jurisdictions, to aid in the development of the NWT GHG Strategy that will ultimately be implemented by the GNWT. The mandate of this committee is to;

- contribute to the development of a NWT GHG Strategy, addressing GHG reductions that take into account regional, sectoral and socio-economic issues.
- develop and evaluate a range of options for GHG reduction in all sectors in the NWT and to ensure a clear and broad understanding of the implication of the options.

Dillon Consulting Limited in association with Terriplan Consultants Ltd. and Lawson Environmental Services were retained by the working committee to assist in the development of background data that will be used in support and the development of the NWT GHG Strategy.

1.2 Report Organization and Structure

The background work completed by the Working Committee and subsequently enhanced by the Dillon team generated a large volume of information and data. The intent of this report is not to restate the available information that was collected during this study. The intent of the report is to summarize the work completed, and provide a concise report on the impacts of the initiatives put forth to address the GHG emissions.

Section 2 of this report describes the approach taken to the assignment. A description of the work program, information sources, and methods used to develop the impacts to the GHG emissions are described herein.

Section 3 of this report describes the specific initiatives that were proposed by the Working Committee, and the expected impacts that these initiatives will have on the GHG emissions. The sections also describes the expected impacts that the implementation will have on the general NWT populous with respect to socio-economic issues, life style, economy, etc.

Section 4 is a summary section that brings together the cumulative impacts of the various initiatives described in section 3.

The appendices include some of the background data that was collected during the completion of this assignment. The appendices, however, are by no means exhaustive in the information that is contained. It should be recognized that there has been a tremendous amount of research, data collection, data correlation, reports, and papers on this subject generated at the national level, and at each provincial/territoriallevel. The appendices are a collection of the most pertinent information that was accessed in the development of this report.

2.0 Approach

The Working Committee has developed a series of sub-committees to address specific issues. These sub-committees over the past several months worked to develop initiatives within a set sector. The division of the sectors mirrored the division of the National Tables, and used the work completed by the National Table as much as possible in developing initiatives. The work of the National Tables was not complete at the time of preparing this report. These sectors are;

- Industrial
- Electrical
- Public Administration
- Residential/Commercial
- Transportation
- Small Sector/Cross Cutting

The initiatives developed by the sub-committees were provided to Dillon with an indication of the relative priorities for the initiatives. The total number of initiatives were close to one hundred with close to 30 identified at high priority.

The priority initiatives were screened to determine which should be carried forward for further analysis. The initial screening criteria as discussed with the Working Committee were:

- The initiatives need to be achievable.
- There should be short term initiatives as well as long term initiatives.
- Initiatives that cannot be analyzed due to too little data, or other, can be deleted at this time, realizing that the strategy will be revisited on a periodic basis and updated as data becomes available. Initiatives deleted now, can therefore be re-assessed at a later date for implementation.
- The NWT Reduction Strategy is looking at mitigative measures. The National Strategy will look at mitigative measures, science and technology advancement, and adaptation.

Based on the screening of the initiatives, the following groupings of the "achievable" priority items were developed.

Group 1 - Public Education and Outreach

1. Public Awareness/Education
2. Implement No Idling Policy
3. Preventative Maintenance

4. Introduce energy management into school curriculums or post secondary courses
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17. Supply Clean Energy to mining industry
18. Replacement of diesel generators with systems that will significantly reduce levels of greenhouse gas emissions; development of hybrid generation systems; and promote the development and application of renewable energy technologies.

Items 11, 12, and 15 were identified by the GNWT's Energy Efficiency Study Committee as cost saving measures which could be implemented within the GNWT. Expansion of the measures beyond GNWT operations has been proposed to reduce greenhouse gas emissions throughout the NWT.

Development of a NWT Emission Reduction Energy Policy was recognized as an important measure to finally indicate government support for energy projects which could contribute to greenhouse gas emission reductions in the NWT. Such a policy would document the GNWT's commitment to renewable and "cleaner" energy sources, potentially stimulating private enterprise to develop energy supply projects with lower GHG reductions than conventional technologies.

The groups were developed, where any one item can be implemented without the others. The information that is provided on these items is separated to allow for the understanding of the individual impact as well as the cumulative impact of the initiatives.

3.0 Analysis

3.1 Group 1 Initiatives

3.1.1 Introduction

The public awareness and education component of a NWT GHG Emissions Reduction Strategy, referred to as Group 1 Initiatives, needs to be considered within a hierarchy of "measures" and "actions". Broadly speaking, a measure can involve any instrument requiring government involvement, such as regulations or incentives. A "measure" is a specific program initiative that will stimulate one or more actions, for example, the introduction of energy management into school curricula. An "action" is a specific step taken to reduce GHG emissions, for instance, the implementation of a no idling policy.

The Working Committee directed that a number of potential components (also referred to as options) in Group 1 be reviewed. Presented below is a listing of the components reviewed and their grouping.

Components Reviewed	*Measure*	*Action*
Public Awareness and Education	✔	
Introduce Energy Management Into School Curricula	✔	
Driver Rewards	✔	
Increase Telecommunications	✔	
Vehicle Inspections and Preventative Maintenance		✔
Implement No Idling Policy		✔

Presented below is a summary of the key measures and initiatives reviewed using a format that links as closely as possible the findings in Group 2 and 3 initiatives. Additional supporting information is provided in Appendix A.

3.1.2.1 Public Awareness/Education

Climate change is one of the most important environmental, economic and political challenges of the

coming century. However, despite Canadians' strong concern for the environment, they have limited awareness and understanding of climate change as an issue. Compared to other societal concerns, such as health care, the economy, and education, climate change has yet to command the attention of Canadians.

Public awareness and education is essential if Canadians, including Northerners, are to understand what climate change means to them, and if they are to take action to reduce personal GHG emissions. Outreach is also critical in building public support for broader policies and actions, such as those identified in Group 2 and 3 initiatives in this report, that will have to be put in place as governments and businesses move to address climate change. Work at the national and provincial levels has clearly demonstrated that lack of awareness of climate change is a key element in limiting voluntary initiatives at the individual, public and private sector level.

The interaction among policy development, public outreach activities, and actions to reduce GHG emissions in various sectors of the economy must be ongoing and synergistic. Neither sector-specific measures nor public outreach initiatives alone can be as effective as an integrated overall strategy. Public awareness and education, therefore, necessary element in the design and implementation of the National Climate Change Implementation Strategy and a NWT GHG Emissions Reduction Strategy.

The National Public Education and Outreach Table Options Report - *"Reaching Out to Canadians on Climate Change"* (Draft, June 1999) has identified three key objectives, all of which are consistent with the principles and objectives set out in *"Doing Our Part"* a Workshop Report on the development of a strategy to control greenhouse gas emissions in the NWT:

- to build awareness and understanding among Canadians of climate change, its impacts and the associated environmental, economic and social issues;
- to recognize that climate change is a priority issue and develop support from Canadians for policy changes and actions that will be required , as part of the National Climate Change Implementation Strategy; and
- to encourage and motivate Canadians to take personal action to reduce greenhouse gas emissions.

The ultimate goal of a public awareness and education strategy is to facilitate the movement of key sectors of society from being "target audiences" to becoming the "key players" in practising and encouraging others to adopt less greenhouse gas intensive lifestyles. In short, to enable Group 2 and 3 initiatives to be initially accepted and ultimately supported. This is a key strategic factor given that the economic, social and political implications of progressively more aggressive initiatives to reach what in reality means a 25% reduction in GHG emissions from the *"business as usual"* projections as an aggregate of the provinces and territories across Canada by the year 2013. The work completed during this assignment has affirmed the fact that while climate change is truly an "environmental"

issue, it has to be recognized and managed initially as an "economic and political" issue.

The National and Public Education and Outreach Table Options Report involves a mosaic of approaches to engage Canadians and Northerners. While local initiatives need to be emphasized, broad based national activities are designed to create an integrating backdrop to support activities across the country. There must be a clear and focussed message for every region of the country. The provinces and territories should not attempt to undertake a public awareness and education initiative on their own given the benefits of pooling resources and more importantly reducing audience "fatigue" with the GHG issue. The conclusion based on the review work conducted through this assignment is that there is virtually every communications and consultation tool already "out there" and what remains is to harness them.

At the national level, the strategy focuses primarily on approaches that promote understanding and awareness about climate change, and engage the Canadian public, using advertising, media relations, and national events. This component of the strategy promotes a climate change brand identity designed to encourage values and norms that support reducing GHG emissions. Branding is a proven way to enhance awareness building initiatives and provide an umbrella under which organizations can position their own initiatives (e.g., United Way/Centraide). The National and Public Education and Outreach Table Options Report recommended that approximately 20 percent of the public education and outreach resources be allocated for national activities.

At the local level, the primary focus would be to equip, encourage and motivate people to take action to reduce GHG emissions. This requires a strong effort in building awareness and understanding of the climate change issue through educational activities, as well as promoting action and behaviour change. The National and Public Education and Outreach Table Options Report recommended that approximately 80 percent of the public education and outreach resources be targeted at this level.

Priority audiences have been targeted because of their relative lack of engagement to date, or because of their ability to reach and raise awareness among others.

Public

The general public is the overall audience for the entire strategy. Activities focus primarily on a branded national advertising campaign, media relations activities, and national events, using credible spokespersons to deliver clear, consistent messages. Several broad themes and specific messages have been developed and tested with focus groups to gain a preliminary determination of what resonates best with the public.

Aboriginal Peoples

Aboriginal Peoples represent half the population of the NWT need to be engaged more fully through this education and outreach initiative. The rationale for including Aboriginal peoples as a discreet audience is based on two key factors: Aboriginal Peoples have a unique role to

play in educating Canadians about the GHG issue. The economic, spiritual and holistic perspective that is the foundation of Aboriginal Peoples lives lies at the core of some of the changes needed across all sectors of society to begin to respond to the challenge of climate change; secondly, the impacts that climate change will have on many resource based local communities and economies.

Communities

Communities and municipalities represent both key target audiences and important partners in the implementation of the public education and outreach strategy.

Youth

Youth is an important audience for public education and outreach as they are the decision makers, business people, consumers, homeowners, and parents of the future. A flexible, project based program has been developed for youth, guided by the concept of engagement, rather than marketing, and providing opportunities for rewards and recognition.

Educators

The formal education system is a primary means to reach youth and educators, when provided with the tools and opportunities, can effectively reach out to students and their families to build awareness and motivate action.

Business and Industry

Business and industry have been selected as a target audience because of the potential leadership role they can play in demonstrating action to the public and in communicating to their key audiences (including employees, suppliers, and consumers).

Media

The media are a key audience because of their ability to confer legitimacy on, and make the public aware of an issue. The focus of activities would be on community based, specialty and feature media.

A proposal implementation process of the public education and outreach options report has been well developed in the national table and should provide an appropriate framework for the NWT. The first, or foundation, phase (2000-2001) focuses on building a base for support and understanding around climate change. Activities in this place enhance and support existing community and nationally focussed initiatives, as well as pilot new and promising approaches. This phase features the creation of a national, multi sectoral, advisory board. This board will guide the overall strategic direction of the public education and outreach activities and links communities to each other and to national efforts.

The second, or engagement, phase (2002-2004) features co-leadership by government and non-government partners and the development of multi-sector national and regional "centres" or "hubs". These centres bring together committed stakeholders to work collaboratively on public awareness and promotional activities, programs to increase Canadians' understanding of climate change, relevant research, and community based initiatives that motivate behaviour change.

The third, or integration, phase (2005 and beyond) sees the realization of independent, arms-length management of public education and outreach by all stakeholders through national and regional centres or hubs, much like the United Way/Centraide model. Leadership is shared among all partners, and funding comes from multiple sources.

3.1.2.2. Benefits

The public awareness and education initiatives cannot be quantified in any meaningful way.

3.1.2.3 Emissions Reductions

The public awareness and education initiatives cannot be quantified in any meaningful way.

3.1.2.4 Implementation and Monitoring

The public awareness and education initiatives cannot be quantified in any meaningful way.

3.1.2.5. Description of Costs

The public awareness and education initiatives cannot be quantified in any meaningful way.

3.1.2.6. Cost Effectiveness

The public awareness and education initiatives cannot be quantified in any meaningful way.

3.1.2.7 Sources of Uncertainty/Areas for Further Analysis

The public awareness and education initiatives cannot be quantified in any meaningful way.

3.1.3.1 Introduce Energy Management Into School Curricula

In the NWT the Department of Education, Culture and Employment has already initiated this measure (See Appendix A: Education, Culture and Employments, Initiatives in Education for more detailed information). The education component begins early in the school career in both the Sciences and Social studies curricula and continues through to the next school levels. This commitment is part of the Western Canada Protocol (WCP) Curriculum for Social Studies. This approach emphasizes stewardship of nature (which is also emphasized in the sciences curriculum), sustainable development and the interaction of humans and the environment - including climate change issues. In addition, there are a number of proposed changes to the NWT Science Curricula based on the Pan Canadian Common Framework of Science Learning Outcomes 1997 (PCCFS) that will further strengthen this overall measure.

In the Social Studies area environmental awareness and sustainable development is being addressed in Social Studies 20 and 23 where students learn about the characteristics of sustainable development and extrapolate to situations in the NWT.

On the sciences side, materials relate to the environment, environmental issues, pollutants and sustainability. The current NWT science curriculum is targeted at various grade levels including: Primary Grades 1 to 3; Intermediate Grades 4 to 6; Junior High 7 to 9; and, Senior High.

Other Related School Initiatives

Destination Conservation - is a school energy efficiency retrofit program that engages school principles, custodians, students and teachers as well as the community. The program teaches students about energy, water and waste conservation and about their role in protecting the environment. Since its beginnings in Alberta, it has expanded to other Canadian provinces including Ontario, Saskatchewan, British Columbia and New Brunswick. The Destination Conservation Program has three progressive levels - starting with lifestyle initiatives, then moving to more formal school curricula development and a "technical/utility initiative" component.

The Arctic Energy Alliance initiated a three year Destination Conservation Pilot Program with the three schools in Yellowknife Catholic School District No. 2 in June 1997. The participating schools are required to pay a program access fee of $500 for the first year and $350 for each subsequent year. The program access fee covers some of the costs of developing and maintaining the Destination Conservation Program. The three participating schools in Yellowknife have focused on the first element - lifestyle initiatives.

There are a number of other related school initiatives that some jurisdictions have implemented. These related initiatives are briefly described below but as no comparable NWT initiatives were identified, they are not outlined in any detail.
The Walking and Biking School Bus program establishes safe walking and biking routes for kids

going to school – children walking or biking meet at designated locations and travel together with a parent volunteer (part of Active and Safe Routes to School program).

The No-Idling program establishes no-idling zones in front of schools to encourage drivers of vehicles to turn off their cars (part of Active and Safe Routes to School program)

Becoming an efficient buyer – Green purchasing programs can have positive impacts on the reduction of greenhouse gases by promoting office supplies containing recycled content, purchasing locally and eliminating packaging. Governments Incorporating Procurement Policies to Eliminate Refuse (GIPPER) is an initiative by Canadian federal, provincial and municipal governments to promote reduction, reuse and recycling during purchasing.

3.1.3.2. Benefits

The program teaches students about energy, water and waste conservation and about their role in protecting the environment. It provides energy efficiency and environmental supporting curriculum and also pragmatic, hands-on experience.

One of the unique features of the program is that it is largely self-financing. Local utilities will fund the early part of the program retrofits which is later paid back through the savings. Further savings are poured back into the school in the form of more progressive energy efficiency retrofits.

3.1.3.3. Emission Reductions

Schools participating in Alberta's model program reported on average 30% savings in the utility bills (up to 70% electricity savings and up to 25% gas savings).

3.1.3.4. Implementation & Monitoring

Monitoring is built into the program.

Energy savings provide accurate measurements and results.

3.1.3.5. Description of Costs

TransAlta Utility provided an initial sum of $2,000 per school.

Destination Conservation reported a total cost of $23,500 to deliver the program to 10 schools over the three year period.
The costs are recouped through revenue savings from energy retrofits.

An approximate cost of $30,000 per year for the NWT may be appropriate.

3.1.3.6. Cost Effectiveness

The Destination Conservation Program has a formal evaluation scheduled for the end of year three. There have been two annual reports (FASER energy accounting software) comparing energy and water consumption and costs that provide some preliminary insight into the program's benefits and potential.

Using a baseline year of April 1996 to March 1997 selected overall results for electrical and heating are presented below. Water data is incomplete at this time and is not included.

Category	June 1998-May 1999	June 1997-May 1998
Avoided Electrical Costs	$8,494	$4,017
Avoided Electrical Consumption	78,602 kWh (51%)	29,389 kWh (1.92%)
Avoided Electrical Demand	43 kW (0.8%)	132 (2.3%)
Avoided Heating Fuel Costs	$10,343	N/A
Avoided Heating Fuel Consumption	32,834 L (8.3%)	N/A

Participating schools in Alberta's model program reported 25% savings on their utility bills.
To date the program has saved participating schools in Alberta (~300 schools) more than $700,000.
Average saving per school is $2000 /year.

3.1.3.7. Sources of Uncertainty/Areas For Further Analysis

Pilot projects to be identified and implemented in the NWT to test feasibility.

3.1.4.1. Driver Rewards Program

This initiative rewards people for making changes in their driving habits that benefit the environment. There are a number of existing programs in place in other jurisdictions. Some example programs are briefly described below.

The Toronto Transit Commission has partnered with an insurance company (Peoples Plus Insurance) to provide a discount on car insurance for transit users who have signed up for the annual transit pass program. The annual transit pass program enables transit users to pay in advance for the monthly transit pass over a one year period.

Students of the NRCan driver training program are taught about fuel efficiency driving techniques as part of the Auto$mart program.

Alternative Transportation

Subsidize public transportation – Several programs have been developed to encourage employees to use public transportation as the mode of transportation to work. The State of Maryland has introduced the Commuter Choice tax credit bill enabling companies to offset subsidies paid to employees who take public transportation. Some companies are offering subsidies including Hewlett-Packard Company.

Van pooling - Jack Bell Vanpool Program in Vancouver organizes up to 8 commuters living close together – commuters are charged monthly fares. The vans are purchased with interest free loans from the Richmond Savings Credit Union.

Promoting alternative transportation in the workplace – Vancouver's Go Green Choices program encourages businesses and organizations to bring alternative transport option to the workplace. Implemented Employee Trip Reduction Program. Nissan, U.S.A. has developed its Commuter Service Program to encourage employees to use alternative modes of transportation

3.1.4.2. Benefits

No quantitative data were available

3.1.4.3. Emission Reductions

No quantitative data were available

3.1.4.4. Implementation & Monitoring

Part of the individual programs or projects

3.1.4.5. Description of Costs

An approximate cost of $20,000 per year is put forth to carry out pilot projects to determine feasibility..

3.1.4.6. Cost Effectiveness

No quantitative data were available

3.1.4.7. Sources of Uncertainty/Areas For Further Analysis

Pilot projects to be identified and implemented in the NWT to test feasibility.

3.1.5.1 Increase Telecommunications

Telecommuting – this policy enables employees to work at home at least part of the time. Nortel, Bell Canada and AT&T have specific programs enabling employees to telecommute.

Telecommuting enables employees to work at home using computers, modems, fax machines and telephones to communicate with co-workers and business contacts. Nortel introduced its "Homebase" telecommute program in 1994. About 4,000 Nortel employees, representing about 5% of the total workforce, telecommute, under the "Homebase" program. 55% work at home one or two days per week and 45% work at home full time.

The potential of increased use of video and teleconferencing is another area that could be considered. The internal "normal" business practice of using video and teleconferencing limits the availability of data on how many organizations are participating.

3.1.5.2 Benefits

Savings in generation of greenhouse gases due to transportation to and from work.

Possible reduction in health care costs due to reduced stress (i.e., from transporting to and from work).

Reduced transportation time results in more time spent with family. Reduced sick leave.

Nortel reports:

- 30% improvement in productivity
- 46% reduction in work stress
- 45% improvement in work satisfaction
- $8 million savings in reduced real estate

3.1.5.3. Emission Reductions

According to the Canadian Telework Association, if 1 million Canadians telecommuted 1 day per week, they would save 200,000 tonnes of greenhouse gases, 21 million litres of gas.

Nortel reports over 14,000 tonnes reduction in green house gases due to its telecommuting program. Each day per week spent telecommuting results in 20% decrease in vehicle emissions.

3.1.5.4. Implementation & Monitoring

Monitoring can be achieved by monitoring work productivity.

3.1.5.5. Description of Costs

Some companies subsidize the cost of setting up an office in the home.

Addition long-distance phone costs incurred.

The City of San Diego allotted $US300 per participant for training and $US30/month for phone costs.

The City of San Diego reports the need of 5-15% of one administrator's time to administrate program.

For the NWT, an annual cost of $700,000 for phone lines and computers may be appropriate. Capital costs would be in the order of $100,000.

3.1.5.6. Cost Effectiveness

Estimated $34 million savings in fuel costs if 1 million Canadians telecommuted 1 day per year (Canadian Telework Association).

$ savings in reduced real estate.

$ savings in reduced sick leave (10-20% experienced by City of San Diego during 6 month pilot project).

$ reduced employee turnover (Nortel reports 24% reduction in employee turn over).

City of San Diego reports $US350 per year savings in vehicle operating costs.

The potential savings associated with video and teleconferencing are difficult to establish due to the "normal" business practices which rarely include a formal benefit/cost analysis.

3.1.5.7. Sources of Uncertainty/Areas For Further Analysis

Pilot projects to be identified and implemented in the NWT to test feasibility. NorthwesTel has developed infrastructure and facilities in some major centres in the NWT and Yukon. The application and feasibility assessment should include any "results" from NorthwesTel.

3.1.6.1. Vehicle Inspections and Preventative Maintenance

Fleet Maintenance - Companies and government agencies can adopt policies to have regular maintenance checks on their fleet vehicles including checking the pressure of the tires, using recycled oil during oil changes, maintaining minimum loads, having regular tune-ups. The Federal Government has established the FleetWise program which is a planning program for fleet managers.

Work with local gas stations to develop a car maintenance campaign which encourages people to check the pressure of their tires on a regular basis, remove unnecessary racks, undergo regular oil changes and tune-ups, etc. This idea has been proposed only, no known campaigns are currently underway.

Develop a program with the local municipality or community group to provide car maintenance workshops and provide resource kits (including a tire pressure gauge and the Auto$mart and EnerGuide for vehicles handbooks).

Fleet Conversion- some communities are converting their fleets (public transportation or operating fleets) to less greenhouse gas intensive fuels. For example the Cities of Cornwall and Hamilton, Ontario are converting their public buses to run on natural gas. The City of Montreal has a campaign to encourage businesses to convert their fleets to electrical vehicles.

Drive Clean Programs – vehicles must undergo inspection every year or two to ensure that they are road worthy and the engines are well maintained. Several program operate in Canada including Clean Air Program in Ontario and the Air Care Program in British Columbia which tests exhaust systems of vehicles.

Vehicle emission testing program whereby vehicles must undergo testing at certified, participating inspection stations. Vehicles must pass the clean air test or undergo recommended repairs.

Cars, light trucks and sport utility vehicles less than 20 years old must undergo testing before renewal of vehicle registration.

Testing in Ontario occurs every other year.

Heavy trucks are scheduled for testing by year 2000.

3.1.6.2. Benefits

Reductions in smog result in better health and reduced respiratory problems.

On-road vehicles are the number one source of smog in some Canadian jurisdictions.

10% of vehicles on the road are responsible for 60% of emissions (a poorly maintained car pollutes 20 times more than a well maintained car).

Improved fuel efficiency and fuel costs (see appendix A: *Outdoor Quality in Toronto and Respiratory Health* (Anti-Smog Strategy) Board of Health, City of Toronto, 1996.)

3.1.6.3. Emission Reductions

British Columbia's AirCare program has resulted in 3% reduction in NOx, 18% reduction in VOCs and 24% reduction in carbon monoxide. Appendix A contains detailed references as cited in *Outdoor Air Quality in Toronto and Respiratory Health* (Anti-Smog Strategy) Board of Health, City of Toronto, 1996.

Ontario estimates 22% reduction in smog causing pollutants.

3.1.6.4. Implementation & Monitoring

Vehicles must undergo testing prior to renewing the sticker on the license plate.

Testing is done by the model year of the vehicle with even year models tested in year 1 and odd year models tested the alternate year.

Failure to pass the inspection requires repair and retesting.

The City of Denver has a variation on the program by encouraging the public to report "smoking" vehicles that are then required to undergo an inspection.

3.1.6.5. Description of Costs

Substantial costs to implement program.

Vehicle owners pay $30 per inspection (in Ontario).

Start-up cost will be on the order of $20,000, with annual cost in the order of $25,000.

3.1.6.6. Cost Effectiveness

Estimated in Ontario that health care costs resulting directly to car related air pollution are $646 million annually.

Potential fuel savings of average $125 per vehicle annually.

3.1.6.7. Sources of Uncertainty/Areas For Further Analysis

Pilot projects to be identified and implemented in the NWT to test feasibility. The practical limitations of implementing that initiative outside of the larger regional centres needs to be fully considered. Infrastructure, equipment and support resources are a key limiting factor in many smaller communities.

3.1.7.1. Implement No Idling Policy

This initiative encourages people to turn-off their cars when not in use. The climate conditions of targeted area will impact on the design of the policy.

Some communities have enacted no-idling by-laws, such as the City of Toronto which requires that drivers cannot idle their vehicles longer than 3 minutes or they face a $105 fine. Montreal has introduced similar idling control legislation (See Appendix A: *Idling Control Bylaw: Public Education and Implementation Plan*, Department of Health, City of Toronto, 1996)

3.1.7.2. Benefits

Drivers required to turn-off engines after 3 minutes of idling or face $105 in fines.

Bylaw doesn't apply to police, fire, ambulance or armoured vehicles, or emergencies that stall traffic.

Transit buses may idle no longer than 15 min.

3.1.7.3. Emission Reductions

Up to 4% fuel use due to unnecessary idling.

Assume average car emits 5 tonnes green house gas annually.

Emission savings per car is 250 kg per year.

10 seconds of idling uses more fuel than restarting the engine.

An estimate 12% of smog results from idling.

3.1.7.4. Implementation & Monitoring

City needed to obtain Ontario government's permission to levy fines.

Monitoring is expected to be a problem.

City Bylaw Enforcement Officers are responsible for enforcement.

Training has been provided to City of Toronto Bylaw Enforcement Officers.

3.1.7.5. Description of Costs

Enforcement, if increased otherwise nominal cost increases (i.e., advertising). IN some cases additional enforcement resources (staff and transportation) will be required to give the initiatives legitimacy from a public perspective.

3.1.7.6. Cost Effectiveness

Health care savings from reduced smog and air pollution (a report by the Canadian National Air Issues Coordinating Committee estimates that 1 million tonne reduction in SO_2 emissions will avoid $1-7 million health costs per year). (See Appendix A: *Outdoor Air Quality in Toronto and Respiratory Health* (Anti-Smog Strategy), Board of Health, City of Toronto, 1996).

Avoided fuel costs (3.5 litres per hour of idling).

Costs to enforce the policy could be in the order of $50,000.

3.1.7.7. Sources of Uncertainty/Areas For Further Analysis

Drivers can idle if temperature goes below 5°C or above 27°C. This is a key consideration given the climate in the NWT.

Pilot projects to be identified and implemented in the NWT to test feasibility. The climatic factors may be problematic for significant period of the year, thus making monitoring and/or enforcement both difficult and not cost effective.

There is also a need to consider the feasibility of implementing a no-idling initiative through either: a voluntary action as part of a public awareness campaign; municipal by-law; or a formal government policy. Depending on what instrument is selected, it will determine the enforcement and monitoring approach.

3.1.8.1 Replacing Marine Services for Aviation Services

This initiative encourages the use of marine services (barges) instead of the use of aviation services to transport non time sensitive cargo to the communities off the road system. This covers the communities along the Mackenzie River from Wrigley to South of Inuvik, and the Communities of Tuktoyaktuk, Sachs Harbour and Holman Island.

3.1.8.2 Benefits

The intended benefit is to remove the pressures on the air cargo industry, to an extent that would reduce the number of flights, or decrease the size of the planes flying to the impacted communities.

3.1.8.3 Emission Reductions

To determine the emission reductions, the values that would be required relate to;

- percent of current air cargo that is not time sensitive, and therefore available to the marine market,
- percent of scheduled air links flown that would not be effected by decrease in cargo demand due to the passenger demand,
- current and projected future carrying capacity of both industries. This relates to the fact that a small increase or decrease in demand may not change the number of flights. To reduce the number the flights to a community that receives three flights a week, the volume must decrease by one third,

The above information is not readily available from either the airline industry nor the barge industry. Therefore no determination can be made for the potential reduction in GHG emissions.

A rough guestimate of the value can be obtained from the following exercise;

Percent of population in impacted communities	10%
Percent reduction in cargo off airlines total	30%
Ratio of passenger to cargo as demand driver	50%
Buy in ratio	50%
Efficiency in GHG reduction (IE marine mile to air mile)	90%
Resultant in 1999 would equal - 238 x .1 x .3 x .5 x .5 x .9	1.6 kt

3.1.8.4 Implementation & Monitoring

Implementation would require the public to accept the use of marine services for non time sensitive goods.

There will be a need to in community storage, either at the personal or at the community level.

It may result in a decrease in the number of scheduled air craft to the communities. This will impact the delivery of other services to the community, eg dental care. These other services will need to assess the value of longer community stays, or the use of charter aircraft. Increased costs to the service delivery is possible. The use of charter aircraft would negate the benefit of the initiative.

As this is a consumer driven initiative, the implementation and monitoring will follow the public outreach initiatives.

3.1.8.5 Description of Costs

The cost to the government with this initiative is similar to the cost of any of the other voluntary programs described in the previous sections. A start up cost of $20,000 and an annual cost of $20,000 for public outreach would be appropriate.

3.1.9. Evaluating Results & Success: Group 1 Considerations

Group 1 "type" initiatives are clearly unique with respect to the relevance of certain quantitative measures and evaluation criteria that had been initially outlined by the Working Committee. The national table has recognized the value and ongoing need for the evaluation and monitoring of not only specific activities, but also the strategy as a whole to assess its effectiveness in achieving results, its progress in implementation, the ongoing rationale, and the value for money achieved.

Given the fact that many Group 1 type initiatives cannot be directly quantified or measured in any meaningful way, the national table has recommended the development of an "evaluation framework that will set out, in detail, how the success of the strategy will be monitored and evaluated - presumably utilizing quantitative as well as qualitative measures which are logically linked to Group 2 and 3 type initiatives. Such a framework will set out the "results" to be achieved, as well as performance indicators and management strategies to meet the dual needs of program management and accountability. The Working Committee should adopt and modify the evaluation framework as needed to meet the needs and circumstances of the NWT.

Subsequent evaluations will need to measure the strategy's effectiveness and efficiency in meeting each of the primary objectives - building awareness, developing support for change, and motivating action. The evaluation should also be based on it's contribution to the implementation of Group 2 and 3 initiatives.

3.2 Group 2 - Energy Management Summary and Residual Heat

3.2.1.1 Introduction to Energy Management

Energy Management refers to measures undertaken to reduce energy consumption and use energy more effectively. By virtue of reduced consumption and using energy more appropriate to end use needs, energy management actions result in GHG emission reductions. Previously, energy management initiatives have been driven by the desire to reduce energy demand and consumer costs. However, energy management can also be pursued for the purpose of reducing GHG emissions.

The GNWT and, to a lesser degree, electrical utilities in the NWT have promoted energy management for many years; however, opportunities for further energy management initiatives and resulting GHG emission reductions are possible. Six energy management measures are proposed to reduce emissions in the NWT. A further measure, establishment of residual heating systems, is also proposed and is discussed following the energy management measures.

3.2.1.2 Proposed Initiatives

Uptake of past and current energy management opportunities has largely been voluntary and driven by cost incentives. For the most part, measures proposed herein to reduce GHG emissions also require voluntary adoption by NWT residents, businesses and governments. Personal behavior and choices will largely dictate the uptake of the proposed measures and associated emission reductions. The proposed package of measures will provide opportunities for individuals and organizations to reduce energy consumption and GHG emissions, in many cases saving money. It is proposed that the following six measures be implemented as a package for maximum impact:

- Energy Management Public Awareness/Information Campaign- intended to educate the public about energy management activities, benefits and influence on climate change;
- Elimination of Territorial Energy Subsidies – removal of subsidies so that consumers pay the full cost of the energy they consume and are presented with a price incentive to conserve;
- Development of a NWT Emission Reduction Energy Policy – to support use and development of renewable and cleaner sources of energy and to promote energy efficiency in GNWT contracts/projects;
- Support to communities- technical support to municipalities to reduce emissions. The majority of NWT emissions are generated within municipalities;
- Establishment of an Energy Retrofit Revolving Loan Fund – to finance, at attractive rates, retrofits of existing facilities to reduce emissions; and
- Adoption of Energy Efficiency Codes for new construction – Establishment of code requirements to ensure energy efficient new facilities with lower emissions than conventional construction.

3.2.1.3 Emission Reductions

Most proposed measures are voluntary making it impossible to accurately and defensively quantify emission savings. It is reasonable to expect that the proposed measures could result in an overall reduction in energy consumption and associated emissions of approximately 10% in situations where active energy management initiatives are implemented. Assuming an aggressive uptake of energy management initiatives by consumers representing 50% of existing energy use, then the proposed initiatives could result in total emission reductions of 5%. It is reasonable to expect that these possible reductions would be restricted to the electrical generation and stationary combustion sectors as reported in the 1996 NWT Emission Inventory. Total combined emissions for these sectors were 591kt in 1996, which reduced by 5% would result in annual emission reductions of approximately 30 kt of greenhouse gases. Uptake of the energy management initiatives would occur over the period to 2013, at which time the 5% reduction has been assumed to be achieved.

Table 3.1 - Impact of Energy Management Initiatives

Proposed Measure	Cost		% GHG Reduction
	One Time	Annual	
Public Awareness/Information		**$100K (1.3M total)**	
Elimination of Energy Subsidies		**$5.3M ***	
Emission Reduction Energy Policy	**$150K**		
Support to Communities		**$50K ($650K total)**	
Energy Retrofit Loan Fund	**$1M**		
Adoption of Energy Codes	**$150K**		
Totals (as of 2013)	**$1.3M**	**$30M**	**30 kt**

*Potential $5.3M annual savings after 2007 when measure is fully implemented.
For more details on each of these initiatives please refer to Appendix B.

3.2.1.4 Implementation Issues

Energy management activities are currently being supported by the GNWT. Measures proposed under the emission reduction program would extend the influence of current energy management programs. Significant implementation issues related to measures proposed include:

- Full implementation costs and effects.
- Effect of eliminating energy subsidies currently provided by GNWT.
- Determination of effective and efficient delivery mechanisms.
- Effect of voluntary uptake on success of proposed measures.

3.2.2.1 Introduction to Residual Heat

Most communities in the NWT receive electrical energy generated by diesel generating plants located within municipal boundaries. The production of electrical energy from diesel fuel is an inefficient process, as only about 40% of the thermal energy contained in the diesel fuel is converted into electrical energy. The remaining energy in the diesel fuel is lost as heat. The Northwest Territories Power Corporation (NWTPC) has initiated several projects in the NWT and Nunavut to exploit the residual heat from the diesel-electric generation process to provide space heating in their own and other public facilities. Considerable experience with residual heat systems has been gained over the years. In 1997, the first commercially oriented residual heating project was implemented in Ft. McPherson by Aadrii Ltd., a joint venture between the Gwich'in Development Corporation and the NWTPC. Performance data from 1997 indicate heat from the system in Ft. McPherson displaced 149,600 litres of heating fuel for its customers and 153,000 litres in 1998. The system appears unlikely to achieve the design goal of 250,000 litres of displaced heating fuel per year. GHG emission reductions are directly linked to the volumes of fuel displaced.

3.2.2.2 Proposed Initiatives

Further implementation of residual heating systems at additional diesel-electric generating stations presents the opportunity for additional reduction of greenhouse gas emissions in the NWT. A study commissioned by the NWTPC to review the potential for residual heating systems in the NWT and Nunavut recommended that the feasibility of implementing systems diesel plants in Holman Island and Ft. Simpson be subject to further investigation.

3.2.2.3 Emission Reductions

Table 3.2 illustrates the greenhouse gas emission reductions achieved by the Ft. McPherson system in 1998.

Table 3.2 - 1998 Greenhouse Gas Emission Reductions, Ft. McPherson Residual Heat System

Fuel Volume ($000m^3$)	*CO_2*	*CH_4 ($ktCO_2E$)*	*N_2O ($ktCO_2E$)*	*Total ($ktCO_2$)*
0.153	0.433	0	0	0.433

Results from 1998 demonstrate that the fuel displaced by the system resulted in a reduction of emissions of approximately 0.433 kt CO_2 E compared to the design goal of 0.708 kt CO_2E. Table 3.3 indicates the estimated emission reductions based on original forecasts.

Table 3.3 - Forecasted Annual Emission Reductions, Ft. McPherson Residual Heat System

Fuel Volume ($000m^3$)	CO_2	CH_4 ($ktCO_2E$)	N_2O ($ktCO_2E$)	Total ($ktCO_2$)
0.250	0.708	0	0	0.708

Implementation of residual heat systems in Holman Island and Ft. Simpson have the potential to further reduce greenhouse gas emissions in the NWT. In the absence of detailed information about potential emission reductions for systems in these two communities, Table 3.4 estimates potential emission reductions based on expected reductions for Ft. McPherson during 1999. Further analysis would be required to accurately quantify actual potential emissions achievable.

Table 3.4 - Potential Annual Emission Reductions from Residual Heating Systems in Holman Island, Fort Simpson and Fort McPherson

Community	Fuel Volume ($000m^3$)	CO_2	CH_4 ($ktCO_2E$)	N_2O ($ktCO_2E$)	Total ($ktCO_2$)
Ft. McPherson	0.160	0.453	0	0	0.453
Holman Island	0.160	0.453	0	0	0.453
Ft. Simpson	0.160	0.453	0	0	0.453
Total	0.480	1.36	0	0	1.36

Accordingly, based on this imprecise analysis, operation of residual heating systems in the communities of Ft. McPherson, Holman Island and Ft.Simpson could result in annual greenhouse gas emission reductions of 1.36 kt or approximately 0.1% of the total NWT greenhouse gas emissions for 1996.

The capital costs for the Ft McPherson system was $ 1,132,837. Operating losses for 1997 were $23,953. More recent operating cost data was not available during this study.

3.2.2.4 Implementation Issues:

Aadrii's initial business plan indicated the project was expected to return a profit during its fourteenth year of operation. Based on one year of operational data, it appears that this original forecast may have been overly optimistic. The following factors have been noted by NWTPC as important in the determination of the financial viability of implementing new residual heating projects:

- Price of heating fuel – In many NWT communities fuel prices are subsidized by the GNWT, making alternative energy less attractive than if full cost pricing was in effect.
- Location of Power Plant in Community – the heat distribution network is usually the largest capital cost of a system, greater distances from source to end users result in greater capital costs.
- Plant Electrical Demand- The primary function of the diesel-electric plant is to produce electricity for customers. The amount of thermal energy available for distribution is limited by the electrical demand.
- Potential Thermal Demand- heating load within proximity of plant must be large enough to justify capital costs.
- Power Plant Physical Size – the availability of space within the plant to install heat recovery equipment will decrease capital costs – the need to provide auxiliary space for equipment will increase capital costs.
- Community location – transportation costs of materials to site and local construction costs all impact capital cost of system.
- Customer Acceptance – if there is no financial benefit to customers they may be unwilling to support the project on purely environmental grounds.

These factors would need to be evaluated during the recommended feasibility studies for new systems in Ft. Simpson and Holman Island. Residual heat recovery is a very good greenhouse gas reduction initiative although the current systems may have marginal economics.

3.3 Group 3 Fundamental Shift in Energy Use

3.3.1 Introduction

A review of the GNWT Greenhouse Gas Emission Forecast for the Northwest Territories reveals that one sector accounts for the majority of the total annual emissions in the NWT. The Stationary Fuel Combustion Sector, which includes emissions resulting from power generation; commercial, residential and public building heating; and industrial operations, contributes approximately 60 to 70% of the total GHG emissions for all years forecasted. In order to realize significant reductions in the overall NWT GHG emissions, it would be most effective to concentrate reduction efforts on the major contributing sectors, where even a moderate percent reduction will have a noticeable impact on the overall total.

Significantly reducing GHG emissions in the Stationary Fuel Combustion Sector requires a switch to a cleaner fuel or energy system. Incremental reductions through energy management initiatives have been discussed in a previous section. Given the current technological state of alternative or renewable energy systems, it was decided by the Working Committee that the study would focus on hydro power and natural gas. The potential for GHG emission reductions focussed on three hydro/natural gas initiatives: developing the Liard and Beaufort gas reserves and converting communities to natural gas, linking the Taltson and Snare hydro systems and providing hydro power, or natural gas to mining developments in the central Slave Geological Province (SGP).

3.3.2 Proposed Initiatives

Recent studies estimate that natural gas reserves in the Mackenzie Delta/Beaufort Sea region may total 64 trillion cubic feet. Additionally, there have been several significant new discoveries in the Fort Liard region. As a fuel source, natural gas emits approximately 68% of the greenhouse gases per GJ of energy released as diesel. Currently, diesel fuel is the primary source of heating and electrical energy in NWT communities, therefore switching to natural gas from diesel may result in significant reductions in GHG emissions. If the natural gas deposits in the NWT are developed, and a pipeline is constructed to transport natural gas from the Mackenzie Delta to southern consumers, emissions reductions may be achieved by converting communities along the pipeline routing from diesel fuel to natural gas. It should be noted that natural gas collection and processing also results in GHG emissions, which will partly offset any reductions realized by using natural gas as a fuel source.

The second initiative focuses on improving the efficiency of hydro power distribution in the NWT. The NWT Power Corporation currently generates hydro power from two locations: the Taltson system south of Great Slave Lake, and the Snare hydro system north of Great Slave Lake. Under current load requirements, approximately 10 MW of unused power can be generated at the Taltson system. This power could be used elsewhere to reduce the dependency on diesel power. Communities on the Snare system also use diesel powered electrical generation to meet peak and

hourly demand loads. If the two hydro systems were to be connected, the excess power generated at the Taltson hydro site could be transferred to the Snare system, displacing an equivalent volume of diesel fuel currently required to meet the demand on the Snare system. As hydro power emits very few GHG's, emissions reductions achieved by tying the systems together could be significant.

Supplying hydro power or natural gas to mining developments in the central SGP is an extension of the first two initiatives. The operation of the BHP mine site and the proposed new mines in the central SGP are forecast to contribute a significant volume of GHG emissions to the NWT total. By 2013, the contribution is estimate to be 18% of the NWT total. It may be possible to achieve a significant GHG reduction by supplying these sites with a cleaner fuel source. The feasibility of supplying natural gas to the properties is contingent upon a stable supply of gas being transported down a pipeline through the Mackenzie Valley. For the purpose of evaluation, two mine sites are used.

3.3.3 Emissions Reductions

The potential emissions reductions achievable under these initiatives are presented in Table 3.5. Potential reductions were estimated by calculating an emissions footprint for each NWT community in 1996, based upon information contained in the *GNWT Greenhouse Gas Emissions in 1996 for the Northwest Territories and Nunavut*. Further information on fuel usage was also obtained from the NWT Power Corporation and Northland Utilities Limited. Based upon this footprint, each community was assigned a percentage of the total NWT emissions. This percentage was applied to the emissions forecast to 2013 contained in the GNWT Greenhouse Gas Emission Forecast for the Northwest Territories. It was then possible to apply the reductions initiatives to each affected community, and modify the total NWT GHG emissions accordingly. These calculations include the additional emissions generated from the production of natural gas. Spreadsheets and detailed calculations are contained in Appendix C.

Table 3.5 - Potential Emissions Reductions

Year	Total Forecast Emissions	Total Forecast Emission with Natural Gas	% Reduction	Total Forecast Emission with hydro and Natural Gas	% Reduction
1999	1429	1367	4	1322	7
2005	1538	1430	7	1359	12
2013	1746	1626	7	1538	12

The NWT Power Corporation commissioned a study into the feasibility of connecting the hydro systems on the north and south sides of Great Slave Lake. Preliminary estimates place the cost of tying the two systems together at $66.7 million, in 1999 dollars. The diesel emissions displaced as a result of this measure are estimated at 25.4 kt CO_2 per year equivalent. Assuming a 50 year life, capital cost per kt CO_2 works out to $52520/kt$CO_2$.

The cost of supplying hydro power to the SGP is estimated to be on the order of $50 million, with GHG emission reductions of up to 146 kt CO_2.per year. Assuming a 50 year life, capital cost per ktCO_2 works out to $6849/kt$CO_2$.

Preliminary estimates place the cost of converting the Mackenzie Valley communities and the SGP mining developments over to natural gas at $4.9 billion. The emissions reduction, realized as a result of this changeover, are estimated at up to 140.55 kt CO_2 per year equivalent. Assuming a 40 year life, capital cost per kt CO_2 works out to $0.9 million per kt CO_2.

3.3.4 Implementations Issues

Implementing any of the above initiatives will have socio-economic and environmental effects which will have to be considered. Potential implementation issues will include:

- Fuel constitutes a major portion of the material carried on the barges which resupply the Mackenzie Valley and Kitikmeot communities. If the communities are converted to natural gas, the cost of shipping dry goods by barge may increase to offset the reduction in revenue gained through the shipment of fuel.

- If a pipeline is constructed up the Mackenzie Valley, the likelihood of a parallel all weather road being constructed increases. This will affect barge traffic, and may increase the cost of the Kitikmeot resupply. The barge staging area may be moved to Inuvik, resulting in job losses in Hay River but job creation in Inuvik.
- Environmental impacts as a result of the construction of a natural gas pipeline down the

Mackenzie Valley, or to the central SGP are inevitable. Any such project would require a Comprehensive Environmental Impact Review as currently defined under the Canadian Environmental Assessment Act, and/or the Mackenzie Valley Resource Management Act.

- Environmental impacts as a result of the construction of power transmission infrastructure to the central SGP are inevitable. As above, an Impact Assessment would be required.

- The development of the infrastructure to provide the alternative energy to the communities will require significant capital, and this will generate economic growth. There will be a short term boom in the construction industry, followed by a longer term sustained employment for infrastructure maintenance.

It was beyond the scope of this project to fully develop these issues, but they will have to be factored into any justification for implementing the Fundamental Shift in Energy Use initiatives.

4.0 Summary

The development of a GHG Strategy by the GNWT is understood to be an iterative model, where initiatives undertaken in the early part of the strategy will be monitored, and adjusted over time. Some initiatives that are discarded now may, as the strategy develops, be re-assessed and ultimately become part of the long term strategy to reduce the production of GHG emissions in the NWT. This report provides some of the foundation for the first iteration of the Strategy that will be developed by the Working Committee. The Strategy Components will likely fall into the three groups that were used in this report:

- Public Education and Outreach - this area is essential in developing the public support and participation required to implement a successful strategy. The capital cost associated with this group will be low. The implementation for this group will be early in the strategy, and should be the lead of the initiatives. The implementation will be continuous over the term of the strategy.
- Energy Management - this area is the reduction of GHG emissions through the wise use and conservation of energy. In essence it is the better application of the energy technologies that are currently in place in the NWT. Developing a public awareness through the implementation of the Group 1 initiatives is an essential part of the success of any energy management initiatives. It is the public's participation in the reduction of their energy use, whether at home or work that will result in the reduction of GHG emissions.
- Fundamental Shift in Energy Use - this area is the most capital intensive, but has the greatest impact on the long term change in GHG emissions. The scenarios put forth in this report outline significant changes in the energy delivery infrastructure which will result in changes to the base economies of the communities.

Within each group several initiatives were assessed for implementation. The cost of the implementation, impact on GHG emissions and ancillary impacts were developed to a qualitative level. Some initiatives lent themselves to the development of qualitative values based on test cases, actual fuel consumption values, and hard data. Other initiatives are currently being undertaken in other jurisdictions, and pilot scale values are available for costings and impacts. Still more initiatives are very theoretical in their long term costs and potential impacts on GHG emissions. A summary of the proposed initiatives, the order of magnitude costs, the percent reduction in GHG emissions, and the significant impacts from the initiatives is shown in Table 4.1

Table 4.1 Summary of Proposed Initiatives

Initiative	*% reduction in GHG Emissions*	*Expected Life*	*Start up /Capital Costs*	*Operational Costs*	*Capital cost/t CO_2*
Public Awareness/ Education	N/A	50 years	$75K	$25K	N/A
Implement No-Idling Policy	0.12% (1.8kt CO_2)	50 years	$0	$50K/ year	0$
Vehicle Inspection and Preventative Maintenance	0.37% (6.9 kt CO_2)	50 years	$50K	$25K	$6.9
Introduce Energy Management into School Curricula	0.19% (2 kt CO_2)	50 years	$2K/school	$30K/ year	$600
Driver Reward Programs	N/A	N/A	N/A	$20K/ year	N/A
Increase Telecommunication	0.49% (7 kt CO_2)	50 years	$100K	$700K/ year	$14
Replace Marine Services for Aviation Services	0.1% (1.6 kt CO_2)	50 years	$20K	$20K	$12.5
GROUP 1: TOTAL	**19.3 kt CO_2**	**50 years**	**$260K**	**$783K/ year**	
Elimination of Territorial Energy Subsidies	N/A	50 years	$0	$32M total (see table 3.1)	N/A
Development of NWT Emission Reduction Energy Policy	N/A	20 years		$150K (over 2 years, see table 3.1)	N/A
Establishment of an Energy Retrofit	30 kt CO_2	20 years	$1M	$0	$1.6

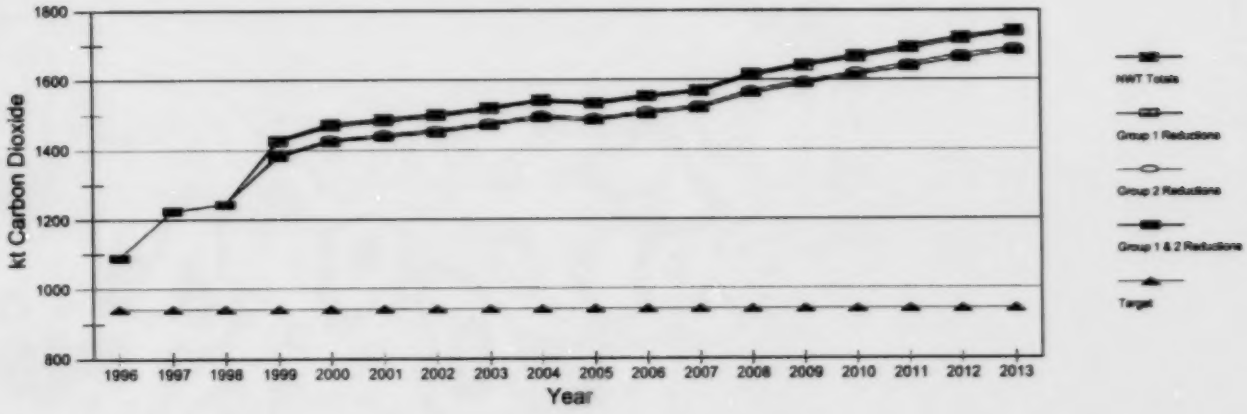
Initiative	*% reduction in GHG Emissions*	*Expected Life*	*Start up /Capital Costs*	*Operational Costs*	*Capital cost/t CO_2*
Revolving Loan Fund					
Adoption of Energy Efficient Codes for New Construction	N/A	50 years	$200K	$150K	N/A
Public Awareness and Education	N/A	50years	$0	$100K/ year	N/A
Support Municipalities	N/A	50 years	$0	$50K/year	N/A
Development of Residual Heat Energy Technologies	1.3 kt CO_2	50 years	$4M	User pay	$60
GROUP 2: TOTAL	**31.3 kt CO_2**	**50 years**	**$1.28M**	**$225K**	
Renewable Energy Technology	1% (14.3 kt CO_2)	50 years	$66.7M		$93
Supply Clean Energy to Mining Industry	7% (100 kt CO_2)	50 years	$50M		$1
Replace Diesel Generators with Systems that will Significantly Reduce GHG Emissions	7% (100 kt CO_2)	50 years	$4.9B		$98
GROUP 3: TOTAL	**214.3 kt CO_2**	**50 years**	**$5.0B**		

The charts below, Chart 4.1 and Chart 4.2, graphically illustrate the above summary table. Chart 4.1

illustrates the impact of group 1 and 2 initiatives on the "Business as Usual" scenario. A total of approximately 3% reductions are applied on an annual basis. Chart 4.2 illustrates the impact of the group 3 scenario, and the resultant savings to the GHG emissions from the change in the energy use. The values that generate these charts can be found in appendix C.

Chart 4.1: Total Emis. for 1996-2013

not including new oil and gas

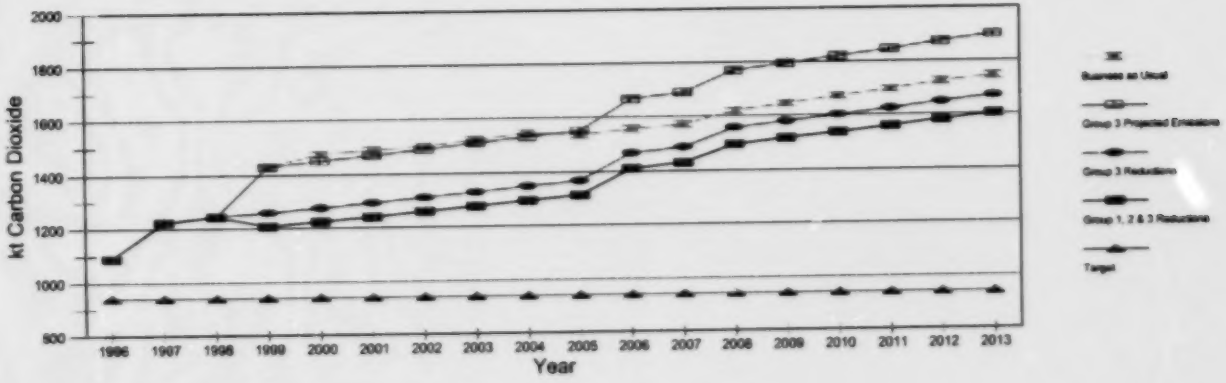


Analysis:

- If we continue to produce emissions at current levels they will reach 1744 $ktCO_2$ by 2013
- Target emissions for 2013 identified by the Kyoto Protocol are 942 $ktCO_2$, 46% below 1999 levels.
- Group 1 would reduce emissions by 0.5% to a level of 1735 $ktCO_2$ by 2013, 84% above the Kyoto target.
- Group 2 would reduce emissions by 3.0% to a level of 1692 $ktCO_2$ by 2013, 80% above the Kyoto target.
- After group 1 & 2 reductions, emission levels are at 1683 $ktCO_2$ by 2013, 79% above the Kyoto target.

Chart 4.2: Total Emis. 1996-2013

including new oil and gas



Analysis:

- If we continue to produce emissions at the current levels they will reach 1744 $ktCO_2$ by 2013.
- Target emissions for 2013 identified by the Kyoto Protocol are 942 $ktCO_2$, 46% below 1999 levels.
- New emissions created by the development of new oil and natural gas resources would increase emissions to 1898 $ktCO_2$ by 2013, 100% above the Kyoto target.
- Group 3 would reduce emissions by 12% to a level of 1670 $ktCO_2$ by 2013, 77% above the Kyoto target.
- Groups 1, 2 & 3 would reduce emissions by 15.5% to a level of 1604 $ktCO_2$ by 2013, 70% above the Kyoto target.

Appendix A: Group 1

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Northwest Territories Green House Gas Emissions Work Program
Group 1: Short Term, Low Capital
Public Awareness/Education Programs

Category and Initiatives	Description	Monitoring	Benefits	Emission Savings	$ Costs	$ Savings
No Idling Program						
- City of Toronto No Idling Bylaw (passed October 1999)	· drivers required to turn-off engines after 3 minutes of idling or face $105 in fines · drivers can idle if temperature goes below 5_C or above 27_C · bylaw doesn't apply to police, fire, ambulance or armored vehicles, or emergencies that stall traffic · transit buses may idle no longer than 15 min.	· City needed to obtain Ontario government's permission to levy fines · Monitoring is expected to be a problem · City Bylaw Enforcement Officers are responsible for enforcement · Training has been provided to City of Toronto Bylaw Enforcement Officers	· reductions in smog and green house gas emissions (air pollution and smog results in estimated 2-4% respiratory deaths and estimated 5% increase in hospital admissions in Southern Ontario during summer months)[1] · Canadian Government estimates that up to 16,000 premature deaths per year are related to ambient air pollution in Canada[2] increased public awareness of the climate change problem · easy, convenient contribution that the individual can make · reduce engine wear	· up to 4% fuel use due to unnecessary idling assume average car emits 5 tonnes green house gas annually emission savings per car is 250 kg per year 10 seconds of idling uses more fuel than restarting the engine an estimate 12% of smog results from idling[3]	- enforcement, if increased otherwise nominal cost increases (i.e. advertising)	· health care savings from reduced smog and air pollution (a report by the Canadian National Air Issues Coordinating Committee estimates that 1 million tonne reduction in SO_2 emissions will avoid $1-7 million health costs per year)[4] avoided fuel costs (3.5 litres per hour of idling)

Vehicle Inspection and Preventative Maintenance						
Drive Clean Program – British Columbia and Ontario	· vehicle emission testing program whereby vehicles must undergo testing at certified, participating inspection stations. Vehicles must pass the clean air test or undergo recommended repairs · cars, light trucks and sport utility vehicles less than 20 years old must undergo testing before renewal of vehicle registration · testing in Ontario occurs every other year · heavy trucks are scheduled for testing by year 2000	· vehicles must undergo testing prior to renewing the sticker on the license plate testing is done by the model year of the vehicle with even year models tested in year 1 and odd year models tested the alternate year failure to pass the inspection requires repair and retesting the City of Denver has a variation on the program by encouraging the public to report "smoking" vehicles that are then required to undergo an inspection	· reductions in smog result in better health and reduced respiratory problems · on-road vehicles are the number one source of smog in some Canadian jurisdictions · 10% of vehicles on the road are responsible for 60% of emissions (a poorly maintained car pollutes 20 times more than a well maintained car)[5] · improved fuel efficiency and fuel costs	-British Columbia's AirCare program has resulted in 3% reduction in NOx, 18% reduction in VOCs and 24% reduction in carbon monoxide - Ontario estimates 22% reduction in smog causing pollutants	-substantial costs to implement program - vehicle owners pay $30 per inspection (in Ontario)	· estimated in Ontario that health care costs resulting directly to car related air pollution are $646 million annually[6] Potential fuel savings of average $125 per vehicle annually
Energy Conservation in the Home						
Green Communities	· Green Communities is a non profit organization whose purpose is to promote energy and water conservation and waste reduction in the home · There are over 20 groups operating throughout Canada in small, rural and urban communities · Staff will conduct energy audits in the home and recommend weatherproofing and energy efficiency retrofits · Typical home energy audit lasts two hours and homeowner is provided with a report	· difficult to obtain information on retrofits undertaken by the homeowner without a post-audit or survey · one energy audit study compared electricity and gas savings before and after the home energy audit · EnerGuide provides a standardized rating system for home energy efficiency that can be used as a monitoring technique	· participants in the home energy audit report reductions in energy consumption and cost savings · improvement in home comfort often reported · special energy retrofit loans help encourage more extensive energy retrofits · Yukon Housing Corporation has established the Green Mortgage that rewards energy conservation by offering 1 percent rate reduction on homes that rate 80 on the EnerGuide for Houses	· residential sector accounts for 19% energy use and 18% green house gas contribution in Canada[7] · space heating in north produces CO_2 per house per year: · electricity = 8,400 kg CO_2 · natural gas = 9,500 kg CO_2 · oil = 12,000 kg CO_2 · (assumes 1,200 sq ft semi-detached home)· energy savings range from 7-16%[8] (Green Audit report) · estimated CO_2	· reported costs to conduct a home energy audit ranges from $150 to $300 per home audit (assuming minimal to no subsidy) (does not include cost of energy retrofits)[9]	· estimated savings range from $70 to $330 per house per year (assuming northern location) Green Communities report annual operating expenses ranging from $100,000 to $1 million[10]

	recommending energy retrofits		· Home visits can combine other issues such as water conservation, natural landscaping, composting and waste minimization	savings per house per year · electricity = 600-1,350 kg CO_2 natural gas= 650-1,600 kg CO_2 oil = 850-1,900 kg CO_2		
Alaska Craftsman Home Program Inc.	· The Alaska Craftsman Home Program Inc. is a non-profit organization promoting energy efficiency in new residential buildings. · Since 1985 it has evolved from providing education on energy efficiency to builders to providing training workshops and certification programs · The building manual is critical to the education and training (other technical manual available) · Homes must meet the HOT-2000 energy use goal to become certified as Alaska Craftsman Homes.· The program has certified more than 2,500 home builders and 100 homes ·	· The Alaska Craftsman Home Program does some monitoring of the homes. · The HOT-2000 computer program is considered the more important monitoring tool, providing energy estimates of each home in the program	· the Alaska Craftsman Home Program (ACHP) estimates that it saves up to 80% energy usage over a home built to conventional standards · any ACHP home financed through the Alaska Housing Finance Corporation is eligible to receive a $US 2,500 rebate which can be applied to the mortgage	· using estimates above · space heating in north produces CO_2 per house per year: · electricity = 8,400 kg CO_2 · natural gas = 9,500 kg CO_2 · oil = 12,000 kg CO_2 · (assumes 1,200 sq ft semi-detached home) · assuming 80% savings = · electricity = 6,700 kg CO_2 savings per house per year · natural gas = 7,600 kg CO_2 savings per house per year · oil = 9,600 kg CO_2 savings per house per year	· since 1985, the organization has operated on $2.4 million funds · today, one-third of its funding comes from workshop fees with the remaining coming from annual state grants · annual funding in 1992 was approximately $US 300,000 · to build a home to the ACHP standard is estimated to cost an additional 8% of the home's overall costs ($US 2,000 to $5,000 in energy features)	- the Alaska Craftsman Home Program (ACHP) estimates that it saves up to 80% energy usage over a home built to conventional standards

Energy Management in the Schools					
Destination Conservation	· a school energy efficiency retrofit program that engages school staff and students. · Students and teachers/staff are	· monitoring is built into the program · energy savings provide accurate measurements and results	· The program teaches students about energy, water and waste conservation and about their role in protecting the	· TransAlta Utility provided an initial sum of $2,000 per school · Destination Conservation reported a total cost of $23,500	· participating schools in Alberta's model program reported 25% savings on their utility bills · to date the program has saved participating schools

	responsible for the school's energy conservation goals, developing a school action plan, implementing the school action plan and monitoring the results. · Program has three phases that are implemented over a three year period		environment. It provides energy efficiency and environmental supporting curriculum and also pragmatic, hand-on experience. · One of the unique features of the program is that it is largely self-financing. Local utilities will fund the early part of the program retrofits which is later paid back through the savings. Further savings are poured back into the school in the form of more progressive energy efficiency retrofits. - Schools participating in Alberta's model program reported on average 30% savings in the utility bills (up to 70% electricity savings and up to 25% gas savings)[11]	to deliver the program to 10 schools over the three year period · The costs are recouped through revenue savings from energy retrofits	in Alberta (~300 schools) more than $700,000 · average saving per school is $2000 /year	
In Concert With The Environment, United States	· A energy conservation program delivered to over 600,000 students in grades 6 –12 throughout the United States · The program is fully sponsored by 50 energy and water utilities in the United States · The program teaches students about resource conservation by engaging them in hands-on work · Students evaluated	· Actions are monitored and $ savings and kilowatt hours saved is identified · The EcoBenefits computer program measures the impact of their actions by showing : · reduced pollution, · reduced use of landfill space · reduced impacts to agriculture · preservation of the	· 99% of teachers indicated that the program helped their student understand the link between energy use and the environment the use of commitments is a strong social marketing tool used to encourage greater participation · students help to educate parents in the issue of climate change,	- The U.S. Department of Environment reports that the In Concert With The Environment program has saved an estimated 20,000 tonnes of CO_2 between 1992 and 2000.	· The U.S. Department of the Environment has contributed $US 200,000 to date to supply information materials, facilitators and classroom computers. · One utility estimated it costs $US 20 per student to participate in the program.	- not estimated

	their household use of resources by completing an energy survey in their home and committing to actions that save energy. · A computer program shows the eco benefits experienced when the student engages in the actions · Students sign a formal commitment sheet	natural environment	energy use and energy conservation			
Energy Management in Buildings						
Energy Efficiency Revolving Fund, Edmonton, Alberta	· The City of Edmonton has established a $1 million Energy Efficiency Revolving Fund to promote energy efficiency in its various departments · The fund applies energy efficiency initiatives targeting road, parks and infrastructures · Departments borrow money to finance initiatives and pay back the loan through $ savings in energy (full or partial amount of savings) · Projects must meet a set of criteria (i.e. payback period, emission savings, etc)	- the funding program has established a monitoring and verification protocol to keep track of its money, progress of projects and repayment terms	· The initiatives have provided contract employment to local businesses · Energy savings have also resulted in water conservation · The fund has been used in over $2 million energy efficiency retrofits since 1994	· Since 1995, the City has experienced an estimated 2,700 tonnes annual reduction in green house gas · Total green house gas reductions of 8,100 tonnes since 1995	· initial capital cost of $1 million to establish the fund no annual operating costs reported (administration absorbed by City)	· annual reported utility savings of $200,000 since 1994 total savings since 1994 is $938,000 · reported payback time for initiatives averages 5 years · average payback period for projects implemented to date is 2.9 years
Increase Telecommunications						
Telecommuting (Nortel Canada)	· telecommuting enables employees to work at home using computers, modems, fax machines and telephones to communicate with co-workers and business contacts. · Nortel introduced its "Homebase"	- monitoring can be achieved by monitoring work productivity	· savings in generation of greenhouse gases due to transportation to and from work · possible reduction in health care costs due to reduced stress (i.e. from transporting to and from work)	· According to the Canadian Telework Association if 1 million Canadians telecommuted 1 day per week, they would save 200,000 tonnes of greenhouse gases, 21million litres of gas. · Nortel reports over	· some companies subsidize the cost of setting up an office in the home · addition long-distant phone costs incurred · the City of San Diego allotted $US300 per participant for training and	· estimated $34 million savings in fuel costs if 1 million Canadians telecommuted 1 day per year (Canadian Telework Association) · $ savings in reduced real estate

	telecommute program in 1994 · About 5% (4,000) Nortel employees telecommute, under the "Homebase" program · 55% work at home one or two days per week and 45% work at home full time		· reduced transportation time results in more time spent with family · reduced sick leave · Nortel reports: · 30% improvement in productivity · 46% reduction in work stress 45% improvement in work satisfaction · $8 million savings in reduced real estate	14,000 tonnes reduction in green house gases due to its telecommuting program · Each day per week spent telecommuting results in 20% decrease in vehicle emissions	$US30/month for phone costs · the City of San Diego reports the need of 5-15% of one administrators time to administrate program	· $ savings in reduced sick leave (10-20% experienced by City of San Diego during 6 month pilot project) · $ reduced employee turnover (Nortel reports 24% reduction in employee turn over) · City of San Diego reports $US350 per year savings in vehicle operating costs

1 Toward a New Energy Strategy, by Suzanne Elston. Prepared for the Environmental Agenda for Ontario Project, March 1999.
2 Canada's Response to U.S. EPA Proposal on Transboundary Air Pollution, Government of Canada, 16 March 1998.
3 Smog: Make or Break It, produced by Healthy City Office, City of Toronto, April 1998.
4 Towards a National Acid Rain Strategy, Submitted to the National Air Issues Coordinating Committee by the Acidifying Emission Task Group, July 1997.
5 Smog: Make or Break It, produced by Healthy City Office, City of Toronto, April 1998.
6 Smog: Make or Break It, produced by Healthy City Office, City of Toronto, April 1998.
7 Residential Foundations Paper, Residential Issue Table of the Canadian Greenhouse Gas Issue Tables, 1998.
8 Community Based Home Energy/Environmental Audit Evaluation Project, prepared by Resources Integration Systems Ltd. for the Public Education and Outreach Issue Table, June 1999.
9 Community Based Home Energy/Environmental Audit Evaluation Project, prepared by Resources Integration Systems Ltd. for the Public Education and Outreach Issue Table, June 1999.
10 How to Grow a Community, Green Communities Association, July 1999.
11 Environmental Resource Centre: Destination Conservation profile #82, The Results Centre.

Appendix B: Group 2

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Measure: Energy Management Public Awareness/Information Campaign

Description of Measure:

This measure would be undertaken in conjunction with the overall public awareness and education program proposed under the Group 1 initiatives; however this program would focus on energy management. Under this proposed measure, the energy management public awareness/education program would be coordinated with the Group 1 measure to provide a direct connection between greenhouse gas emissions, climate change and the effect of energy management measures on emissions.

Summary of Measure:

Existing public awareness and education programs would be updated and linked with GHG/climate change information programs to provide a full cause, effect and partial solution approach. Specifically the energy management public awareness/education program would focus on the ability to reduce GHG emissions, but would also address subsidiary benefits such as cost savings and increased energy security. Program material would be developed/updated to address:
contribution of private and commercial energy use to NWT emissions inventory;
explanation and benefits of energy management;
examples of private and commercial energy management initiatives in NWT; and
energy management assistance available (other proposed measures).

Material would disseminate through information pamphlets, presentations, workshops, client liaison, etc.

Emission Reductions:

Emission reductions directly attributable to the public awareness/education measure are unable to be quantified. However, the measure is intended to raise awareness of energy management and stimulate uptake of other proposed measures which would result in emission reductions. It is believed that the awareness/education measure is necessary to lay the groundwork for other energy management measures proposed.

Direct Costs:

Private Capital	$0	
Operating Savings		$0
Government		$100K/annually
Total Lifetime Costs: (2000/01-2013/14)		$1.3 million

Description of costs:

Costs would include 1 PY at $ 75K plus $25K annually to develop/update and disseminate information. Cost savings are possible if this measure is combined with the Group 1 public awareness/education measure.

Cost Effectiveness:

The impact of programs aimed at modifying human behaviour are difficult, if not impossible, to accurately measure. Measurement of such programs often occurs through public opinion surveys or offence statistics. It is not proposed to measure the effectiveness of this program, but accept it as a necessity in raising awareness to support uptake of other proposed energy management measures.

Ancillary Effects:

Energy management initiatives reduce consumption, increase energy efficiency and substitute cleaner energy sources for higher carbon content sources in support of reducing greenhouse gas emissions. Additional benefits of energy management include reducing energy bills for consumers, decreased environmental risks and increased energy security.

Implementation Issues:

Approximately 76% of NWT residents listed English as their first language in the 1996 Canadian Census, suggesting that the materials produced in English could be expected to reach the majority of the NWT's population. Similar information/educational programs are already in place in the Northwest Territories, using established delivery mechanisms. It is expected that this measure will follow existing approaches and benefit from lessons learned during previous programs.

Interest in awareness/educational material may be lower in the NWT than in other jurisdictions because energy costs are subsidized by the GNWT in many communities, so consumers do not pay the full cost of the energy they consume. Additionally a large proportion of private dwellings in the NWT are social housing units where tenants pay very little of their energy consumption costs. Both the energy subsidy programs provided by the GNWT and the high proportion of social housing tenants are impediments to increasing the penetration of energy management initiatives. Therefore the level of personal commitment to energy management initiatives in the NWT may be lower than in other jurisdictions where a higher proportion of consumers are responsible for their own energy costs.

Competitiveness Effects:

N/A

Regional Effects:

This program would be developed at the Headquarters' level and implemented in an equitable manner throughout the regions. The program should not cause inequities among regions.

Significant Stakeholder Effects:

Energy management public awareness/information programs are directed at using energy more effectively and efficiently by energy consumers. Energy management initiatives will provide benefits to consumers through lower energy costs and will be of benefit to energy suppliers by reducing or delaying the need for capital infrastructure to produce and distribute energy.

Sources of Uncertainty/Areas for further analysis:

It is difficult, if not impossible to quantify the effectiveness of public awareness/educationcampaigns and therefore cost effectiveness of same. However, because of the difficulty in accurately measuring program results further analysis is not proposed.

Measure: Elimination of Territorial Energy Subsidies

Description of Measure:

The Government of the Northwest Territories currently provides subsidies to reduce consumers' energy costs in the NWT. The Petroleum Products Division (PPD) of the Department of Public Works and Services provides fuel distribution services in communities not served by the private sector. It has been estimated that reduction of the direct and indirect subsidies by PPD would result in an average per litre increase in the price of petroleum products of about $0.18/ litre (1). In 1998/99 the GNWT's program costs for direct subsidies to customers was approximately $1.5 million.[1] Indirect subsidies further increase the annual cost of the program to the GNWT.

The Territorial Power Support Program (TPSP) was established so that power rates paid by residents and businesses throughout the NWT would be equivalent to the rate paid in Yellowknife The domestic component of the program provides a discount to all NWT residential consumers outside of Yellowknife whose power rates are higher than the Yellowknife area, for the first 700 kilowatt hours consumed each month. The commercial component of the program provides a discount to northern businesses located outside Yellowknife whose power rates are higher than in Yellowknife rate and whose gross revenues are less than $2 million annually. The subsidy to small business is the difference between the community cost and the Yellowknife cost of the kilowatts consumed, up to a maximum of 1,000 kilowatt hours per month. In 1998/99 subsidy expenditures totaled $3.9 million: $3.75 million for residential consumers; $0.121 million for commercial consumers and $0.002 million for the Inuvik utilidor system (1).

Both the PPD and TPSP subsidies are blanket programs with no eligibility restrictions.

The Northwest Territories Housing Corporation provides subsidized housing units to residents of the NWT. In total the NWTHC owns or controls approximately 2,150 social housing units and approximately 200 government staff housing units in 22 communities in the NWT. With the partial exception of electricity the NWTHC pays for the energy consumed by social housing tenants. Tenants are required to pay the first $0.06 per kilowatt hour of electricity consumed, while the Corporation, through local Housing Associations pays the remaining electricity charges. The Corporation spends approximately $10.6 million on energy for its social housing tenants[1]. It is estimated that approximately 50%, or $5.3 million, is spent on heating fuel and electricity for tenants[2].

Additionally, the GNWT further cross- subsidizes energy utility costs by generally paying the higher government rate, whereas residential consumers pay a lower base rate which is then subsidized.

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[1] GNWT's direct subsidy costs for 1998/99 are contained in a draft study provided to GNWT Energy and Utilities Working Group, October 1999.

[2] A 1997 report on Utility Costs in Public Housing in NWT indicates that approximately 56% of utility expenditures were for electricity and fuel. The remaining 43% was spent on water and sewer utility costs.

It is proposed that the energy subsidies currently paid by the GNWT, estimated at approximately $10.7 million in 1998/99, be eliminated over time so consumers pay the full cost of the energy they consume. Paying higher costs for energy will create an incentive to conserve and use energy more efficiently, resulting in a reduction in greenhouse gas emissions.

Summary of Measure:

Energy subsidies provided by the GNWT would be eliminated, eventually requiring consumers to pay the full cost of energy they consume. The elimination of energy subsidies is proposed to be phased over a five-year period to reduce the impact of increased costs to consumers. Energy consumption over this period would be tracked during implementation to determine the effect of reductions on energy consumption, energy intensity and greenhouse gas emissions. Concurrent with the phasing out of energy subsidies would be the development of a "needs based" assistance program to ensure residents who are unable to afford the full cost of energy continue to receive basic energy services.

Emission Reductions:

The emission reductions directly attributable to this measure can not be quantified without further study. It is expected that this measure, in combination with other proposed energy management measures will contribute to an overall reduction in greenhouse gas emissions outlined in the energy management summary.

Direct Costs:

Private Capital:	$ 0
Operating Savings:	Would result in increased costs to consumers
Government:	Savings of $10.7 million annually after full elimination of subsidies, less the required assistance program to overly burdened consumers. Estimated potential annual savings of $5 million annually after elimination of all subsidies.
Total Lifetime Costs:	Net annual savings to GNWT, increased costs to consumers.

Description of costs:

In 1998/99 the GNWT spent approximately $10.7 million on subsidy programs to assist NWT consumers in paying for the energy services they consumed. Eliminating the subsidy programs will result in substantial savings to the GNWT; however, NWT consumers will face significant, and in some cases unaffordable, cost increases. Increased costs to consumers would equal the costs of subsidies. It will be necessary to implement some type of "needs based" assistance program to those who may be overly burdened by the elimination of subsidies. Nevertheless, by eliminating the current blanket energy subsidies, the GNWT would save a considerable amount of money which could be directed at greenhouse gas emission initiatives or other programs.

Cost Effectiveness:

Phased elimination of energy subsidies is part of the package of energy management measures proposed to reduce greenhouse gas emissions. Costs for this measure will be borne by residential and commercial energy consumers in the NWT, while the GNWT will experience cost savings. The GNWT will not realize the total savings of the subsidies eliminated, as some form of assistance program will be required for those overly burdened by this measure.

While costs for consumers will increase this measure will likely act as a significant stimulus for personal action to reduce energy consumption and, consequently, greenhouse gas emissions. It is not possible to quantify the cost effectiveness of this measure without further study regarding consumer reaction to increased prices.

Ancillary Effects:

Elimination of energy subsidies are expected to reduce energy consumption and therefore reduce or delay expenditures on infrastructure required to store and distribute petroleum products, produce electricity and possibly transportation infrastructure. Additionally, full cost pricing of conventional energy sources will put alternatives to the status quo on a level playing field and may stimulate the growth of alternate energy sources which have the potential to further reduce greenhouse gas emissions.

Subsidy elimination will require consumers to to spend more of their income on energy, resulting in less disposable income for other purchases which may negatively impact personal well-being and/or various sectors of the NWT economy. Increased energy costs may also render some northern businesses less competitive than businesses where energy costs are less expensive.

Implementation Issues:

Subsidy programs have been in effect for many years and many residents and businesses have become accustomed to artificially low costs for energy. Current energy subsidies are largely hidden within the price structure: many people are probably not aware they are being subsidized and may believe they are already paying the full cost. Increasing the cost of energy or any other good or service is usually unpopular. Implementation will require strong political commitment and a public information program to ensure successful implementation of this measure

Additionally, the GNWT would have to design a "needs based" assistance program to ensure that those people who can not afford to pay the full costs of energy are not overly burdened by the reduction in subsidies.

Competitiveness Effects:

Elimination of the subsidies will "level the playing field" among energy supply and delivery alternatives available to NWT consumers. Energy options not currently viable may become attractive and the most efficient and cost effective energy solutions will eventually be implemented.

Full cost pricing may have a negative effect on the competitiveness of some northern businesses, which compete with businesses located in locations with lower costs. Business incentive programs currently in place have been developed to assist with such issues.

Regional Effects:

The impact of this measure will be felt largely by consumers outside of Yellowknife and the other larger centres where the real costs of some forms of energy are more than double the subsidised costs.

Significant Stakeholder Effects:

This measure will result in cost savings to the GNWT as a result of elimination of subsidy payments and a possible delay in infrastructure needs. Residential and commercial consumers outside of the major centres will be required to pay the difference between the subsidized costs and the full costs, which in most cases will result in significant cost increases to consumers.

Sources of Uncertainty/Areas for further analysis:

This measure is expected to result in reduced energy consumption and associated reductions in greenhouse gas emissions, however the extent of reductions is uncertain. The impact on personal well-being, economic activity and income assistance programs requires further analysis.

Should it be determined that total elimination of existing subsidies is not practical, renewable and lower emission producing energy sources could be considered for equal levels of subsidization to promote a reduction in emissions.

Measure: Development of GNWT Emission Reduction Energy Policy

Description of Measure:

The GNWT does not currently have a comprehensive policy which promotes energy efficiency and alternative energy sources directed at reducing greenhouse gas emissions. It is proposed that such a policy be developed with the specific intent of supporting initiatives which reduce greenhouse gas emissions. Secondary objectives of such a policy would be to reduce energy consumption and associated costs, increase energy security and reduce environmental risks. A policy would indicate government support for the development of renewable energy and cleaner sources such as natural gas. The policy would also support energy efficiency in the NWT and specifically require the GNWT to consider energy efficiency and energy alternatives in all of its contracts.

Summary of Measure:

Several initiatives have been undertaken to develop an energy policy for the NWT; however, such a policy has not yet been developed. A review of these initiatives and a refocusing of past efforts on the primary objective of reducing greenhouse gas emissions would be required. A consultative process, facilitated by the GNWT and including all stakeholders would be required to develop a practical and well-supported policy. Review of policy objectives and alternatives may identify the need to develop or amend regulatory instruments to further enhance emission reduction opportunities. It is proposed that this effort be led by the Department of RWED, where responsibility for energy management in the GNWT currently resides. The policy would need to examine and support existing and proposed initiatives aimed at emission reductions. Development of the policy could be completed over a 12-18 month period.

Emission Reductions:

Similar to the proposed energy management public awareness/education program this initiative will not result in quantifiable emission reductions. This measure is viewed as a necessary public policy instrument to support practical initiatives which will result in emission reductions. Taken together with public awareness/education programs this initiative would provide the foundation for other specific measures which would directly contribute to emission reductions. It is not possible to quantify emission reductions on this program. Instead it is to be considered part of a package that would help contribute to an overall reduction in greenhouse gas emissions in the NWT.

Direct Costs:

Private Capital	
Operating Savings	
Government	$75K annually for two years
Total Lifetime Costs:	$150K

Description of costs:
Development of the policy would be facilitated by existing staff within RWED and other GNWT and federal government departments. Approximately $75K per year is proposed to be provided to assist with consultation activities and research contracts. Specific instruments contained within a new policy (such as support for green power in GNWT contracts) would likely result in some cost increases to other programs but these would be evaluated against emission reduction benefits during policy development.

Cost Effectiveness:

This proposed measure will not result in direct emission reductions and therefore its cost effectiveness can not be quantified.

Ancillary Effects:

Development of the proposed policy will show support for energy conservation and development and use of renewable energy and cleaner energy sources such as natural gas. It will document the GNWT's commitment to these initiatives and send positive signals to individuals and businesses that are interested in implementing measures which reduce greenhouse gas emissions. Ideally, to be most effective the policy would indicate support for certain financial arrangements which would stimulate projects which contribute to emission reductions.

Implementation Issues:

Several small scale initiatives have been undertaken which have contributed to greenhouse gas emissions (residual heating, wind turbines, etc); however, they have been undertaken in an economic environment which favours conventional energy projects. As a result such projects, while reducing greenhouse gas emissions, have been marginally economic and face barriers to more widespread implementation. Demonstrated support for such initiatives is expected to result in a higher rate of implementation of desirable projects with little effect on existing energy suppliers.

Competitiveness Effects:

Providing policy support to alternative energy types will increase competition among existing energy providers; however, market penetration of alternative energy type is expected to be limited and gradual. Significant disruption of existing market conditions is not expected.

Regional Effects:

The policy would apply to all regions equally and would not be expected to create inequities amongst regions.

Significant Stakeholder Effects:

Establishment of the policy, combined with other measures such as the elimination of subsidies for conventional energy, is expected to stimulate the availability of alternate energy types (residual heat, wind, natural gas) not available to most consumers in the NWT. It will also provide the political support to existing energy providers and other entrepreneurs to take the risks inherent in alternatives to the status quo.

Sources of Uncertainty/Areas for further analysis:

Further analysis of the need for such a policy is not required. The specific policy needs and instruments would be identified during the policy development stage.

Measure: Supporting Municipalities in Reducing Energy Consumption and Greenhouse Gas Emissions

Description of Measure:

Three communities in the NWT; Yellowknife, Fort Smith and Fort Simpson, have voluntarily joined the Partners for Climate Protection, sponsored by the Federation of Canadian Municipalities and the International Council for Local Environmental Initiatives. Signatories to the program commit to reducing greenhouse gas emissions from municipal operations by 20% below 1990 levels within 10 years of joining the program and to reducing community wide greenhouse gas emissions by at least 6% within 20 years of joining the program. Achieving these targets will require the implementation of energy management programs, development of community energy systems, planning efficient communities, promoting the use of public transportation systems and identifying opportunities for energy substitution. Most municipalities in the NWT have few if any resources to develop initiatives in support of the commitments noted above. A major component of municipal operations funding is provided by the GNWT. Current or expanded funding could include monies for projects to increase energy efficiency and reduce emissions or arrangements could be modified to include incentives or penalties related to emission reductions. Additionally, technical staff within the GNWT could be made available to assist communities with the design and implementation of emission reduction projects.

Summary of Measure:

This measure is an extension of the public awareness/education, energy policy and energy retrofit measures proposed within the energy management package. It is directed specifically at municipal emissions which are a significant contribution to total territorial emissions. It would compliment the energy retrofit measure to include community planning, municipal infrastructure and public transportation. Specifically this measure would propose that GNWT officials with responsibilities for community planning, transportation and building services develop planning materials, provide up to date information on energy efficient technologies and approaches, document success stories and provide technical services to communities to assist them in reducing emissions and use energy more efficiently. Basic information such as subdivision siting and orientation to promote energy efficiency is one example of such assistance which could be provided. Training of municipal operations staff in energy management could also be undertaken under this initiative.

Emission Reductions:

Emission reductions would depend on initiatives undertaken. If voluntary targets are achieved by the municipalities already enrolled in the program and other NWT municipalities, the NWT would be able to make significant strides in reducing territorial initiatives in support of federal commitments.

Direct Costs:

Private Capital	$0
Operating Savings	$?
Government	$50K annually
Total Lifetime Costs:	2001-2013 = $650 K

Description of costs:

PY costs would be borne by existing GNWT Program and Service staff. The proposed Energy Retrofit Revolving Loan Fund and municipal funding agreements would provide some capital for implementing projects. The proposed $50K annual budget would be directed at the development and dissemination of municipal program materials, education and training of municipal staff and contracts.

Cost Effectiveness:

Initiatives proposed under this measure would be developed to identify and promote the implementation of potential greenhouse gas emission reduction opportunities proposed or supported by municipalities. As such the responsibility for implementation would rest with the communities, in accordance with recent community empowerment initiatives. Accordingly, this measure like many others proposed under the energy management package, does not directly result in emission reductions. The measure; however, does support the emission reductions proposed by municipalities and should assist them with achieving successful implementation of locally initiated projects.

Ancillary Effects:

Knowledge and expertise developed under this measure would be expected to be made available to all municipalities in the NWT, not just signatories to the Partners for Climate Change Program. Lessons learned under this measure may be transferable to GNWT projects resulting in further emission reductions and potential cost savings.

Implementation Issues:

The success of this measure is primarily dependent on the comittment of municipalities and their access to funds to implement emission reduction programs. With limited resources to expend on initiatives beyond basic municipal services, the level of assistance provided by the GNWT will be an important factor in the success of this program.

Competitiveness Effects:

Activities undertaken under this measure will be initiated by municipalities, who are accountable for local effects on competition.

Regional Effects:

Implementation of projects will occur on the initiative of municipalities and in most cases, with the exception of the reductions achieved, will not have effects outside of municipal boundaries. Opportunities for communities to combine efforts on certain projects could extend benefits to the regional scale.

Significant Stakeholder Effects:

Initiatives supported under this initiative will be undertaken under the direction of and within municipalities. Municipal councils will be responsible for weighing the costs and benefits of projects on their constituents.

Sources of Uncertainty/Areas for further analysis:

This proposed measure is largely an extension of responsibilities of current GNWT Program and Service staff and does not require further analysis prior to implementation. As with other measures proposed regular evaluation of its need and effectiveness is suggested.

Measure: Energy Retrofit Revolving Loan Fund

Description of Measure:

To assist the uptake of energy management actions promoted in the public awareness/education program an energy retrofit loan fund program is proposed. This measure will be aimed at retrofitting existing residential, commercial and municipal facilities in the NWT to increase energy efficiency and/or change to energy sources which are more appropriate for the end use. (A similar internal GNWT program currently exists and is successful in reducing consumption and emissions.) The measure would provide repayable loans at attractive rates to finance energy management initiatives which contribute to a reduction in greenhouse gas emissions. Priority for loans would be given to those projects with the highest potential emission reductions within reasonable pay back periods. Without a financing mechanism such as this many potential emission reduction retrofits may not be implemented.

Summary of Measure:

Under this measure a revolving loan fund would be set up to provide loans to residential and commercial energy consumers to finance projects that would reduce greenhouse gas emissions. Applications would be prioritized according to emission reduction potential and cost effectiveness. Borrowing rates would be attractive; however, loans would have to be paid back promptly to ensure sufficient capital is available for new loans. Projects resulting in larger emission reductions may be given preferential borrowing rates. It is suggested that the program be initially capitalized at $1 million. Annual reporting of projects and emission reductions would be tracked to determine success.

Emission Reductions:

The potential emission reductions from this measure depend on a number of issues including: program design and qualification criteria, financing rates, amount of capital available and market penetration. Potential emission reductions resulting from this measure can not be quantified; however, this measure in combination with other energy management initiatives (ie., reduction of subsidies) is expected to generate significant emission reductions.

Direct Costs:

Private Capital	
Operating Savings	10-20 % on projects implemented
Government	$1 million initial capitalization
Total Lifetime Costs:	$1 million, assuming staff & O & M costs covered in existing energy management budgets.

Description of costs:

It is proposed that an initial $1 million in capital be provided by the GNWT. The loan fund would then be expected to be self-sustaining.

This type of retrofit financing program is commonly offered by Energy Service Companies in southern Canada, but due to the small market and limited potential profits in the NWT it is unlikely that such a company would establish itself in the NWT. Therefore it is recommended that the fund be managed by the GNWT or other not for profit institution to take advantage of existing staff to administer the program. Accordingly, staffing costs would be borne by existing programs and no new O&M funds would be required.

Cost Effectiveness:

Energy retrofit programs in the NWT and southern Canada have proven to be very cost effective with payback periods for projects as low as half a year, but more commonly ranging between 2-5 years of implementation. Research conducted by the Residential Table of the National Climate Change Program indicate that on average every $40 spent on energy retrofit programs results in a reduction of 1 tonne of greenhouse gas emissions (Draft Residential Options Paper, 1999). This figure would expected to be higher in the NWT as a result of higher costs.

Ancillary Effects:

Program implementation would be expected to create employment through renovation projects and may increase demand for some energy types and equipment at the expense of others, with effects on current suppliers. Market penetration would likely be at a rate which would prevent sudden market shifts and allow suppliers to adjust to changing conditions over a reasonable time period.

Energy efficient design and construction expertise will be developed which may prove marketable to other northern and circumpolar jurisdictions.

Implementation Issues:

Energy retrofit loan programs are commonly implemented by Energy Service Companies, which are paid contingent on actual energy savings realized. Energy Service Companies are often subsidiaries of utility companies which provide and invoice customers for energy consumption. Payback of capital retrofit expenditures is directly tied to the customer's utility bill. This provides the customer with the ease of no additional payments and the Company with a payback guarantee. Such arrangements would be ideal; however given the lack of a private Energy Service Company in the NWT and the proposal to have the Loan Fund managed by the GNWT or a not-for profit institution, more conventional (and less attractive) payback measures would have to be implemented. This may have a

result on the uptake of the program. Consideration could be given to having the NWT Power Corporation (NWT Crown Corporation) implement the loan program where electrical energy consumption is displaced.
Additionally the substantial subsidization of energy costs in the NWT reduces the financial incentive for undertaking energy retrofits and thereby reduces the potential to reduce emissions. This factor is addressed in another proposed measure.

Competitiveness Effects:

This measure should not result in any undue burden to the energy or energy service industry as gradual uptake will allow businesses to adjust to changing market conditions.

Regional Effects:

This measure can be implemented on an equitable manner throughout the regions. Consideration could be given to granting priority to regions where energy costs are highest as a result of the proposed elimination of energy subsidies.

Significant Stakeholder Effects:

This measure will benefit consumers and is unlikely to negatively affect energy suppliers at the proposed rate of capitalization.

Sources of Uncertainty/Areas for further analysis:

The specific delivery agent requires further investigation. The Energy Management Program of RWED, operated by the Arctic Energy Alliance currently provides a number of functions in support of energy retrofits but is unable to offer financing to implement solutions. It may be beneficial to have the program administered by this agency to provide a "full service shop"; however, other options may be viable.

Measure: Adoption of Energy Efficiency Codes for New Construction

Description of Measure:

The National Building Code, which governs new construction in the NWT, does not set standards for energy efficiency for facilities. The Model National Energy Code of Canada for Buildings and the Model National Energy Code of Canada for Houses was developed in 1997. Both codes set minimum standards for energy efficiency in buildings and housing; however, the NWT has not adopted either of these codes. Additionally the GNWT has developed several iterations of Design Standards and Guidelines for New Public Buildings which address energy efficiency; however, compliance with these standards is not mandatory in GNWT funded projects.

It is proposed that the GNWT adopt the Model Energy Codes as a companion to the National Building Code. Further analysis of the costs and benefits of these codes should be under taken prior to adopting them.

Summary of Measure:

Review and potential adoption of the Model National Energy Code of Canada for Buildings and the Model National Energy Code of Canada for Houses to set minimum energy efficiency standards for all new construction in the NWT.

Emission Reductions:

The codes will apply to new construction and therefore will not contribute to reductions to current greenhouse gas emissions. However, implementation of energy efficiency codes will reduce the amount of future stationary source emissions and contribute to a reduced growth of emissions in the NWT.

Direct Costs:

Private Capital	5-10% increased capital cost
Operating Savings	10-20% on new construction
Government	$125 K for two years
Total Lifetime Costs:	$250K

Description of costs:

One PY would be required to coordinate an NWT review of the Model Codes over a two-year period. One PY, including overhead costs is estimated at $75K. Additional funds in the range of $50K for each of the two years would be required to support consultation and technical reviews of the

Codes. Existing building and related codes are administered by municipal and territorial government officials. Most of the codes are administer on a fee for service basis. Implementation of the proposed energy codes ould be undertaken with the existing mechanisms and are not expected to result in additional on-going costs. Any additional costs required to implement the program could be collected as a fee for service.

Cost Effectiveness:

While this measure is directed at reducing greenhouse gas emissions, implementation would lower the total life cycle costs of facilities to owners and occupants. Higher initial capital costs would be expected but operational savings over the life of a facility would result in reduced lifetime costs in comparison to conventional construction methods.

Ancillary Effects:

Adoption of Energy Efficiency Codes will stimulate the design and construction of energy efficient buildings and will create specific design and construction experience which may be transferable to other jurisdictions. Potential economic opportunities may arise in other northern or circumpolar jurisdictions, as has been the case with current northern building technology.

Adoption of Energy Efficiency Codes will likely result in increased capital costs and lower O & M costs, combining for lower overall life-cycle costs than less efficient facilities. The increased capital costs are not expected to restrict development opportunities. Over the long term this should make more money available to building owners and occupants.

Implementation Issues:

Adoption of the Codes will impose additional requirements on designers and contractors. This will likely result in higher capital costs which may be perceived to reduce potential profits on the design, construction and sale of buildings. Additionally people may be unfamiliar with some of the energy efficient technologies and/or methods which will be required to meet the new standards. However, northern designers and public housing providers have pursued energy efficient design and construction for many years so considerable experience probably already exists in the NWT.

Competitiveness Effects:

The Codes, if adopted, would be applicable to all new construction in the NWT and therefore would not favour one group or region over another. It may help develop an energy efficient design and construction industry in the NWT which could pursue opportunities in other jurisdictions.

Regional Effects:

The program would be applied evenly across the NWT and so there should be no regional

discrepancies.

Significant Stakeholder Effects:

The proposed measure, while increasing initial construction capital costs, will result in net savings to owners and occupants over the life of a facility. Design professionals and builders may need to acquire new skills to meet the requirements of the Codes.

Sources of Uncertainty/Areas for further analysis:

The economic effects of implementing the Codes must be considered to ensure adoption will not restrict new construction and have consequent negative effects on residents and the northern economy. Such a review is considered necessary before adoption of this measure.

Measure: Residual Heat from Diesel-Electric Generating Stations

Description of Measure:

Most communities in the NWT receive electrical energy generated by diesel generating plants located within the communities. The production of electrical energy from diesel fuel is an inefficient process, with only about 40% of the thermal energy contained in the diesel fuel being converted into electrical energy. The remaining energy in the diesel fuel is lost as heat. The Northwest Territories Power Corporation (NWTPC) has initiated several projects in the NWT and Nunavut to exploit the residual heat from the diesel-electric generation process to provide space heating in their own and other public facilities. Considerable experience and expertise with residual heat has been acquired over the years, resulting in more efficient and cost effective implementation of residual heating projects. However, residual heat from the NWTPC's diesel power plants has only been utilized by a handful of NWT communities. Data for the current analysis was only available for the system in Fort McPherson.

Recently, Aadrii, a joint venture between the NWTPC and the Gwich'in Development Corporation constructed a residual heat system in the community of Fort McPherson. The heating system is a low temperature (90°C maximum) system that uses residual heat from the NWTPC diesel plant to supply supplemental heat to five government owned buildings. The residual heat system supplies thermal energy to existing oil-fired low temp hydronic heating systems. The system was intended to provide approximately 75 % of the annual heating requirements for four buildings and the water-heating load for the summer only community swimming pool. Due to the difference between peak electrical demand and peak thermal demand the system was not able to provide 100% of customer energy requirements. Peak heating demands would continue to be provided by customer heating systems, all of which are oil-fired low temperature hydronic systems.

The diesel plant in Fort McPherson has an electrical generating capacity of 1800 kW_E with an expected peak electrical demand of 757 kW_E. It was estimated that the peak thermal output of the generating system was 600kW_{TH}. Annual thermal energy sales were initially forecast at 1,716 MWh_{TH}, displacing an estimated 250,000 litres of heating fuel for system customers. In 1997, first year of operation, the Fort McPherson residual heating system delivered approximately 1,715 MWh of heat to its customers, displacing approximately 149,600 litres of heating fuel. In 1998 the system displaced approximately 153,000 litres of heating fuel for its customers, while the system is expected to displace approximately 160,000 litres of fuel in 1999. The increasing volume of heat provided and associated displacement of fuel is largely a result of full implementation of the systems in 1998 and installation of exhaust heat recovery equipment in September, 1999.

Summary of Measure:

Residual heating systems would be implemented in communities where cost effective. To recover the heat rejected from the engine, heat recovery exchangers are inserted in the cooling system before the radiators and in the exhaust system before the silencer. These exchangers allow the

engine to heat up a stream of water or glycol, which can then be pumped through a piping system to service the heating requirements of nearby buildings. Residual heat recovery has the potential to significantly increase the energy efficiency of the diesel-electric generating process through the capture of thermal energy which is usually lost as a byproduct of generating electricity.

Under the right circumstances residual heat distribution systems could be developed which would support development costs over a medium term by recapturing some of the customer fuel savings as an energy charge for thermal energy delivered by the system.

An undated study commissioned by the NWTPC recommended that existing residual heat systems continue to operate and the communities of Holman Island and Fort Simpson be subject to further study to determine the feasibility of developing residual heat systems. Residual heat systems may be able to be implemented in these two communities, displacing heating fuel consumption and reducing greenhouse gas emissions.

Emission Reductions:

In 1997 the Fort McPherson Residual Heat system displaced approximately 149,600 litres of heating fuel (Arctic Energy Alliance 1999). The table below indicates the estimated amount of greenhouse gas emissions displaced by the residual heating system in 1997.

Table 1. 1997 Greenhouse Gas Emission Reductions, Ft. McPherson Residual Heat System

Fuel Volume ($000m^3$)	CO_2	CH_4 ($ktCO_2E$)	N_2O ($ktCO_2E$)	Total ($ktCO_2$)
0.1496	0.423	0	0	0.423

Not all customers were connected to the system for the full year in 1997, resulting in lower fuel and emission displacement than potentially possible. In 1997 the residual heat system resulted in emission reductions to the stationary heating-public administration sector of 423 tonnes or 0.423 kt of CO_2 equivalent Table 2 indicates the emission reductions achieved during 1998 when all customers were connected to the system and 153,000 litres of fuel were displaced.

Table 2. 1998 Greenhouse Gas Emission Reductions, Ft. McPherson Residual Heat System

Fuel Volume ($000m^3$)	CO_2	CH_4 ($ktCO_2E$)	N_2O ($ktCO_2E$)	Total ($ktCO_2$)
0.153	0.433	0	0	0.433

At full design efficiency, prior to the installation of the exhaust heat recovery equipment the system reduced greenhouse gas emissions by 433 tonnes or 0.433 kt CO_2Equivalent.

Implementation of residual heat systems in Holman Island and Fort Simspon have the potential to further reduce greenhouse gas emissions in the NWT. In the absence of detailed information about potential emission reductions for systems in these two communities, table 3 estimates potential emission reductions based on reductions expected at Ft. MacPherson in 1999. Installation of exhaust heat recovery equipment in September 1999 in Ft. MacPherson is expected to enhance system performance, displacing an estimated 160,000 litres of heating fuel for its customers. Further analysis would be required to accurately quantify actual potential emissions achievable.

Table 3- Potential Annual Emission Reductions from Residual Heating Systems in Holman Island, Fort Simpson and Fort McPherson

Community	Fuel Volume ($000m^3$)	CO_2	CH_4 ($ktCO_2E$)	N_2O ($ktCO_2E$)	Total ($ktCO_2$)
Ft. McPherson	0.160	0.453	0	0	0.453
Holman Island	0.160	0.453	0	0	0.453
Ft. Simpson	0.160	0.453	0	0	0.453
Total	0.480	1.36	0	0	1.36

Accordingly, based on this crude analysis, operation of residual heating systems in the communities of Ft. McPherson, Holman Island and Ft.Simpson could result in annual greenhouse gas emission reductions of 1.36 kt or approximately 0.1% of the total NWT greenhouse gas emissions for 1996.

Direct Costs:

Documented for Fort McPherson Residual Heating System only.

Private Capital	$1,132,837 (not including 1999 upgrade)
Operating Savings	1997 (-$23,953)
Government	
Total Lifetime Costs:	20 year amortization period

Description of costs:

NWTPC's original capital costs to install the heat recovery equipment were approximately $80,000. These costs were intended to be recovered through a heating charge to Aadrii which would sell the thermal energy to the building customers. Aadrii's capital costs were identified at $ 1,132,837 (not including 1999 upgrade) which included costs for piping, heat transfer stations, construction contracts, design and project management. All capital construction costs were borne by Aadrii. Customers were not charged a connection fee and did not contribute to capital costs of the system.

Customers were charged for the energy delivered to their buildings. The rate charged by Aadrii for thermal energy delivered is essentially 90% of the cost of heating fuel displaced by the system. Rates were proposed to be set annually based on the community fuel costs set by the Petroleum

Products Division of the GNWT.

Aadrii predicted the residual heating system would generate a profit during year 14, based on initial forecasts of system efficiency and revenue from energy sales.

Cost Effectiveness:

Limited data was available to evaluate cost effectiveness of the system. Revenues were less than expected during year one, partly due to the fact that not all planned customers were connected to the system. Initial data indicate that the original forecast of profitability after fourteen years of operation is unlikely to be achieved.

Ancillary Effects:

In addition to reduction of heating fuel consumption and greenhouse gas emissions in the community the Fort McPherson Residual Heating System has had the additional benefit of providing employment through construction contracts and adding to the knowledge of the operation of diesel-electric residual heating systems in the NWT. Due to reduced consumption of fuel by residual heat customers, less fuel is required to be transported and stored, thereby reducing the risk of spills and accompanying environmental degradation. The reduction of fuel volumes may also defer the need for fuel storage and distribution infrastructure.

Implementation Issues:

An undated study commissioned by the NWTPC recommended that the communities of Fort Simpson and Holman Island be subject to further study to determine the feasibility of developing residual heating systems. NWTPC (1998) has identified the following factors affecting the feasibility of Residual Heating Systems:

Price of heating fuel – In many NWT communities fuel prices are subsidized by the GNWT, making alternative energy less attractive than if full cost pricing was in effect;

Location of Power Plant in Community – the heat distribution network is usually the largest capital cost of a system, greater distances from source to end users result in greater capital costs;

Plant Electrical Demand- The primary function of the diesel-electric plant is to produce electricity for customers, the amount of thermal energy available for distribution is limited by the electrical demand;

Potential Thermal Demand- heating load within proximity of plant must be large enough to justify capital costs;

Power Plant Physical Size – the availability of space within the plant to install heat recovery equipment will decrease capital costs – the need to provide auxiliary space for equipment will increase capital costs;

Community location – transportation costs of materials to site and local construction costs all impact capital cost of system; and

Customer Acceptance – if there is no financial benefit to customers they may be unwilling to support

project on purely environmental grounds.

These factors would all need to be evaluated during feasibility studies for new systems.

Competitiveness Effects:
Residual heating systems have the potential to reduce heating fuel consumption in a community, reducing the revenues of the fuel supplier who previously supplied the fuel displaced by the new system. This may result in reduced profits to the supplier and/or increased costs to the consumer as a result of reduced economies of scale for the fuel supplier.

Regional Effects:

Residual heating systems would be developed within communities. Should a system displace a volume of fuel large enough, consumer prices in the community may be effected. T hese price effects may be felt in other communities which receive their fuel from the same supplier.

Significant Stakeholder Effects:

Residual heat systems take advantage of thermal energy lost during the diesel-electric generating process. The costs of generating the electricity (and thermal energy) are recovered through electrical rates. The electrical utility has the potential to increase revenues with the sale of thermal energy which is a byproduct of their main activity. Customers have the potential to receive energy cost savings through the purchase of residual heat rather than heating fuel. Local entrepreneurs have the potential, albeit not currently proven, to generate a profit by distributing the residual thermal energy to customers.

Fuel suppliers may experience reduced sales and revenues which if large enough, may result in an increase of fuel costs to consumers.

Sources of Uncertainty/Areas for further analysis:

For the purposes of this analysis, only one year of performance data from the Fort McPherson Residual Heating System was available. The data available was for 1997, which did not include full implementation of the system. Data from subsequent years is required to fully assess the viability of this system. The system does result in the reduction of greenhouse gas emissions; however, wider implementation of residual heating systems in the NWT will need to be financially viable unless subsidies are provided. The economic feasibility of the Fort McPherson system and potential systems in Fort Simpson and Holman Island requires further analysis before it can be determined if further implementation of residual heating systems are feasible and consequent emission reductions can be achieved.

Appendix C: Group 3

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14. Introduction

The focus of the Group 3 initiatives was to estimate the GHG emissions reductions that could be achieved by switching to cleaner fuels in the Stationary Combustion Sector. To develop this estimate, it was first necessary to establish an emissions footprint for each community in the NWT. A significant quantity of information relating to GHG emissions in the individual communities was contained in the GNWT RWED document Greenhouse Gas Emissions in 1996 for the Northwest Territories and Nunavut, and 1996 was chosen as the base year for developing the footprint. Further information on fuel usage in 1996 was obtained from the NWT Power Corporation and Northland Utilities Limited to supplement the data contained in the GNWT RWED report. **Table 1** contains the emissions footprint for each community in the NWT, and each communities fraction of the NWT total.

Natural Gas Conversion

In the next step, those communities with the potential to be connected to natural gas were identified. The selection was based upon the community's proximity to the likely route of a new natural gas pipeline through the NWT. Two potential routes were considered: from the existing natural gas pipeline at Zama, Alberta to Inuvik, and from the existing natural gas pipeline at Fort Liard to Inuvik. It was considered likely that both natural gas routes would follow the existing oil pipeline route to Norman Wells as much as possible, thereby making use of the existing right of way and access points.

In this scenario, the two potential pipeline routes would come together at Fort Simpson, and travel north up the Mackenzie Valley to Inuvik. The communities considered most likely to be hooked up to natural gas are those along the Mackenzie Valley and in the Mackenzie Delta. These communities were tabulated along with their GHG emissions totals attributable to non natural gas sources. A new set of potential emissions per year were calculated, based upon the conversion of diesel and light oil burning equipment to run on natural gas. The new emissions were calculated using the assumption that natural gas produces 68% of the GHG emissions of diesel per GJ of energy produced during combustion. These potential emissions were then added to the existing natural gas emissions within a community to estimate a new GHG emissions footprint. A GHG reduction factor was calculated for each community. Table 2 contains the potential emissions footprint and natural gas reduction factor for selected Mackenzie Valley and Mackenzie Delta communities.

The community fraction, and the natural gas reduction factors were used to calculate the potential emissions of each community on natural gas through to the year 2013. Table 3 contains the potential GHG emissions for the selected communities.

The total potential emissions reduction for each community for a given year were subtracted from the NWT total forecast for that year. At the same time, the production of natural gas also emits GHG's. The volume of natural gas required to supply the NWT communities in a given year was calculated, and the corresponding emission values were added to the NWT total for that year. Table 4 summarizes the potential emission reductions realized by converting the Mackenzie Valley communities to natural gas.

A rough cost estimate was developed for constructing a pipeline to Inuvik, and connecting the Mackenzie Valley communities. The estimate was based upon the following values:

Cost of constructing the main pipeline:	$4 billion
Cost of constructing branch lines:	$1.2 million/km
Cost of providing residential services:	$1,000/residence
Cost of replacing appliances:	$3,500/residence
Cost of converting public buildings:	$200/$m^2$
Cost of converting commercial buildings:	$200/$m^2$
Cost of replacing diesel generators:	$variable

Individual item cost estimates were obtained from a number of sources. The cost of the main pipeline was the high value reported in news releases concerning the potential development of the Beaufort/Mackenzie Delta gas fields. Construction of the branch lines, the residential services and installation of new appliance cost estimates were obtained from contractors involved with the natural gas project in Inuvik. The cost of converting public buildings is the highest value calculated from GNWT Dept. of Public Works information regarding the installation of new natural gas boilers in public buildings in Inuvik. The cost of converting commercial buildings was assumed to be the same as for public buildings. Diesel generator replacement cost estimates were developed based upon the cost of a new gen set, scaled to community size based upon population. Table 5 contains the results of the estimate in 1999 dollars. Based upon these estimates, the GHG emissions reduction cost works out to $112 million/(kt CO_2) reduced. This value includes the $4 billion cost of constructing the main pipeline. If this cost is removed from the calculation, the cost works out to approximately $3 million/(kt CO_2).

The potential of supplying natural gas to the diamond mines in the central Slave Geological Province (SGP) was also considered. In this scenario, a pipeline would be constructed from the main line running up the Mackenzie Valley to service BHP and Diavik diamond mines. Table 6 contains a summary of the emissions reductions that could be achieved by supplying the diamond mines with natural gas. The cost of supplying BHP with natural gas was estimated to be $768 million. This works out to $9.24 million/(kt CO_2) GHG emissions reduction. This cost is exclusive of the cost to construct the main pipeline up the Mackenzie Valley.

Hydro Development

A second means of reducing GHG emissions in the Stationary Combustion Sector is to use clean, ie hydro, power in place of diesel. Under current load requirements, approximately 10 MW of excess power are generated by the Taltson hydro system south of Great Slave Lake. This excess power could be used by the Snare hydro system north of Great Slave Lake. Supplying an extra 10 MW of power to the Snare system would displace an equivalent volume of diesel fuel which currently provides supplemental power to the Snare system. Displacing 10 MW worth of diesel fuel would result in an emissions reduction of 25.40 kt CO_2 per year. Preliminary cost estimates conducted by the NWT Power Corporation put the cost of tying the two systems together at $66.7 million. Assuming a 50 year life, this works out to a capital cost per kt CO_2 of $52,519/kt$CO_2$ GHG emissions reduced.

Mining development in the SGP makes significant contributions to the NWT's total GHG emissions, and the possibility of supplying these properties with hydro power was also considered. BHP currently uses, and Diavik plans to use, diesel as the primary fuel for providing power to their operations. Waste heat from power generation at BHP is captured, and used to heat the mine buildings, so even if hydro were used as the power source for the mine, diesel or natural gas would still be required to provide heat for their operation. The volume of waste heat available to the minesite was calculated and converted to a volume of diesel fuel. The emissions resulting from the combustion of this volume of diesel were calculated, and became the new emissions value for the mine. It was assumed that Diavik would have a similar waste heat re-use system in place, and its emissions after conversion to hydro power were calculated in the same manner. Table 7 summarizes the emissions reductions possible by supplying hydro power to mining development in the SGP. The cost of supplying hydro to the mines was estimated to be $50 million. This works out to $0.34 million/(kt CO_2) GHG emissions reduced.

Potential Emissions Reductions

Two summary emissions reduction possibilities were considered: converting communities to natural gas and supplying the SGP mining development with natural gas, and converting the communities to natural gas, joining together the Taltson and Snare hydro systems and supplying the SGP mining developments with hydro power. Table 8 summarizes the potential emissions reductions under both of these scenarios.

Table 1: 1996 Emissions Summary

	Power Summary				Commercial Summary						Residential Summary				Public Summary			Community
Community	Diesel (l)	GHG Production (kt CO_2)	Bunker C (l)	GHG Production (kt CO_2)	Light Oil (m^3)	GHG Production (kt CO_2)	Diesel (m^3)	GHG Production (kt CO_2)	Natural Gas (m^3)	GHG Production (kt CO_2)	Light Oil (m^3)	GHG Production (kt CO_2)	Natural Gas (m^3)	GHG Production (kt CO_2)	Commercial Emissions (kt CO_2)	Commercial Fraction of Total	Public Emissions (kt CO_2)	Total (kt CO_2)
Aklavik	935961	2.68		0	306	0.87	18	0.05	0	0	585	1.6	0	0	1.45	0.01	0.49	5.69
Colville Lake	108787	0.31		0	0	0.00	0	0.00	0	0	55	0.16	0	0	0	0	0	0.47
Deline	849.838	2.43		0	148	0.42	9	0.03	0	0	392	1.11	0	0	0.71	0	0.24	4.23
Delsh	0	0.00		0	55	0.16	3	0.01	0	0	123	0.35	0	0	0.27	0.00	0.09	0.61
Enterprise	0	0.00		0	51	0.14	3	0.01	0	0	62	0.18	0	0	0.24	0	0.08	0.41
Fort Good Hope	678344	1.94		0	152	0.43	9	0.03	0	0	427	1.21	0	0	0.72	0	0.25	3.88
Fort Liard	519.305	1.49		0	140	0.40	8	0.02	0	0	287	0.81	0	0	0.66	0	0.22	2.94
Fort McPherson	1.042.117	2.98		0	231	0.65	13	0.04	0	0	674	1.91	0	0	1.09	0	0.37	5.95
Fort Providence	828.543	2.37		0	220	0.65	13	0.04	0	0	457	1.30	0	0	1.08	0	0.37	4.73
Fort Resolution	4272	0.01		0	141	0.40	8	0.02	0	0	382	1.08	0	0	0.66	0	0.22	1.73
Fort Simpson	2347286	6.72		0	1008	2.86	58	0.17	0	0	873	2.48	0	0	4.78	0.02	1.63	13.88
Fort Smith	738881	2.11		0	2814	7.41	152	0.44	0	0	1,591	4.51	0	0	12.38	0.05	4.22	18.69
Hay River	884.502	2.47		0	4,730	13.41	274	0.78	0	0	2,486	7.05	0	0	22.38	0.09	7.63	31.34
Hay River Reserve	0	0		0	0	0.00	0	0.00	0	0	142	0.40	0	0	0	0	0	0.4
Holman	589.437	1.69		0	199	0.48	10	0.03	0	0	326	0.92	0	0	0.8	0	0.27	3.39
Inuvik	9529810	24.41	5.984.809	18.46	4083	11.58	237	0.68	0	0	2,957	8.39	0	0	19.33	0.08	6.59	70.11
Jean Marie River	119.387	0.34		0	0	0.00	0	0.00	0	0	36	0.1	0	0	0	0	0	0.44
Kakisa	134.385	0.38		0	0	0.00	0	0.00	0	0	22	0.06	0	0	0	0	0	0.44
Lutselk'e	400.939	1.15		0	90	0.26	5	0.01	0	0	184	0.52	0	0	0.43	0	0.15	2.09
Nahanni Butte	140442	0.40		0	0	0.00	0	0.00	0	0	49	0.14	0	0	0	0	0	0.54
Norman Wells	14.783	0.04		0	1231	3.49	71	0.20	83,300,000	119.64	650	1.84	28,800,000	54.43	5.82	0.02	1.98	181.62
Paulatuk	314.171	0.9		0	75	0.21	4	0.01	0	0	148	0.42	0	0	0.35	0	0.12	1.66
Rae-Edzo	0	0.00		0	249	0.71	14	0.04	0	0	821	2.33	0	0	1.18	0	0.40	3.46
Rae Lakes	298.968	0.86		0	0	0.00	0	0.00	0	0	129	0.37	0	0	0	0	0	1.23
Reliance	0	0.00		0	0	0.00	0	0.00	0	0	2	0.01	0	0	0	0	0	0.01
Sachs Harbour	332824	0.95		0	165	0.47	10	0.03	0	0	120	0.34	0	0	0.79	0	0.27	2.06
Salt Plains	0	0		0	0	0.00	0	0.00	0	0	10	0.03	0	0	0	0	0	0.03
Snare Lakes	167.538	0.48		0	0	0.00	0	0.00	0	0	78	0.22	0	0	0	0	0	0.7
Trout Lake	97494	0.28		0	0	0.00	0	0.00	0	0	48	0.14	0	0	0	0	0	0.42
Tsiigehtchic	224.378	0.64		0	55	0.16	3	0.01	0	0	125	0.35	0	0	0.27	0	0.09	1.25
Tuktoyaktuk	1.235.816	3.54		0	789	2.18	45	0.13	0	0	686	1.95	0	0	3.64	0.01	1.24	9.04
Tulita	542.330	1.55		0	149	0.42	9	0.03	0	0	293	0.83	0	0	0.71	0	0.24	3.07
Wha Ti	464.657	1.33		0	106	0.30	6	0.02	0	0	192	0.54	0	0	0.5	0	0.17	2.36
Wrigley	324.252	0.93		0	0	0.00	0	0.00	0	0	108	0.31	0	0	0	0	0	1.24
Yellowknife	17.182.358	49.18		0	35553	100.79	2061	5.9	0	0	12,796	36.29	0	0	168.24	0.68	57.34	249.5
Totals	40.029.623	57.18	5.984.809	18.46	52498	148.83	3043	8.71	83,300,000	119.64	28,295	80.24	28,800,000	54.43	248.48	1	84.69	572.16

Note: Emission values were derived by multiplying the community's fraction of the commercial total by the total public emission value.

Table 2: Conversion of Communities to Natural Gas, 1996

Community	Total Emissions ($kt CO_2$)	Potential Emissions ($kt CO_2$)	Reduction ($kt CO_2$)	Reduction Factor
Aklavik	5.69	3.87	1.82	0.68
Colville Lake	0.47	0.32	0.15	0.68
Deline	4.23	2.88	1.35	0.68
Fort Good Hope	3.86	2.62	1.24	0.68
Fort Liard	2.94	2.00	0.94	0.68
Fort McPherson	5.95	4.05	1.90	0.68
Fort Simpson	13.86	9.42	4.44	0.68
Inuvik	49.77	33.84	15.93	0.68
Jean Marie River	0.44	0.30	0.14	0.68
Nahanni Butte	0.54	0.37	0.17	0.68
Trout Lake	0.42	0.29	0.13	0.68
Tsiigehtchic	1.25	0.85	0.40	0.68
Tuktoyaktuk	9.04	6.15	2.89	0.68
Tulita	3.07	2.09	0.98	0.68
Wrigley	1.24	0.84	0.40	0.68
Total	99.83	71.88	27.95	

Table 3: Emissions Forecast After Conversion to Natural Gas

Community	Total Fraction	Net Gas Red Fraction	1999			2000			2001			2002			2003			2004			2005		
			Current (kt CO_2)	With NG (kt CO_2)	Reduction (kt CO_2)	Current (kt CO_2)	With NG (kt CO_2)	Reduction (kt CO_2)	Current (kt CO_2)	With NG (kt CO_2)	Reduction (kt CO_2)	Current (kt CO_2)	With NG (kt CO_2)	Reduction (kt CO_2)	Current (kt CO_2)	With NG (kt CO_2)	Reduction (kt CO_2)	Current (kt CO_2)	With NG (kt CO_2)	Reduction (kt CO_2)	Current (kt CO_2)	With NG (kt CO_2)	Reduction (kt CO_2)
Aklavik	0.0089	0.66	6.4	4.35	2.05	6.54	4.45	2.09	6.66	4.53	2.13	6.74	4.58	2.16	6.89	4.68	2.2	7.04	4.79	2.25	7.03	4.78	2.25
Colville Lake	0.001	0.66	0.53	0.36	0.17	0.54	0.37	0.17	0.55	0.37	0.18	0.56	0.38	0.18	0.57	0.39	0.18	0.58	0.4	0.19	0.58	0.39	0.19
Deline	0.0074	0.66	4.76	3.24	1.52	4.86	3.31	1.56	4.95	3.37	1.58	5.01	3.41	1.6	5.12	3.48	1.64	5.23	3.56	1.67	5.22	3.55	1.67
Fort Good Hope	0.0088	0.66	4.36	2.96	1.39	4.44	3.02	1.42	4.52	3.08	1.45	4.58	3.11	1.46	4.68	3.18	1.5	4.78	3.25	1.53	4.77	3.25	1.53
Fort McPherson	0.0051	0.66	3.31	2.25	1.06	3.38	2.3	1.08	3.44	2.34	1.1	3.48	2.37	1.12	3.56	2.42	1.14	3.64	2.47	1.16	3.63	2.47	1.16
Fort Simpson	0.0242	0.66	15.58	10.6	4.99	15.92	10.83	5.1	16.21	11.03	5.19	16.41	11.16	5.25	16.77	11.4	5.37	17.13	11.65	5.48	17.11	11.63	5.48
Inuvik	0.123	0.66	79.21	53.86	25.35	80.93	55.04	25.9	82.41	56.04	26.37	83.39	56.71	26.69	85.24	57.96	27.28	87.08	59.22	27.87	86.96	59.13	27.83
Jean Marie River	0.001	0.66	0.5	0.34	0.16	0.51	0.34	0.16	0.52	0.35	0.16	0.52	0.35	0.17	0.53	0.36	0.17	0.54	0.37	0.17	0.54	0.37	0.17
Nahanni Butte	0.0094	0.66	0.61	0.41	0.19	0.62	0.42	0.2	0.63	0.43	0.2	0.64	0.44	0.2	0.65	0.44	0.21	0.67	0.45	0.21	0.67	0.45	0.21
Trout Lake	0.001	0.66	0.47	0.32	0.15	0.48	0.33	0.15	0.49	0.33	0.16	0.5	0.34	0.16	0.51	0.35	0.16	0.52	0.36	0.17	0.52	0.35	0.17
Tsiigehtchic	0.0022	0.66	1.4	0.95	0.45	1.43	0.98	0.46	1.46	0.99	0.47	1.48	1.01	0.47	1.51	1.03	0.48	1.54	1.05	0.49	1.54	1.05	0.49
Tuktoyaktuk	0.0158	0.66	10.18	6.92	3.26	10.4	7.07	3.33	10.59	7.2	3.39	10.71	7.28	3.43	10.95	7.45	3.5	11.19	7.61	3.58	11.17	7.6	3.57
Tulita	0.0054	0.66	3.46	2.35	1.11	3.53	2.4	1.13	3.6	2.45	1.15	3.64	2.48	1.17	3.72	2.53	1.19	3.8	2.59	1.22	3.8	2.58	1.21
Wrigley	0.0022	0.66	1.4	0.95	0.45	1.43	0.97	0.46	1.45	0.99	0.47	1.47	1	0.47	1.5	1.02	0.48	1.54	1.04	0.49	1.53	1.04	0.49
Total			132.15	89.88	42.29	135.03	91.82	43.21	137.48	93.48	44.00	139.13	94.61	44.52	142.21	96.70	46.51	145.29	98.80	46.49	145.06	98.69	46.43
Forecast Overall Stationary Combustion Totals (kt CO_2)			644			658			670			678			693			708			707		
Natural Gas Requirement (m^3)				4.7e+07			4.8e+07			5.0e+07			5.0e+07			5.1e+07			5.2e+07			5.2e+07	
Resulting Upstream Emissions (kt CO_2)				4.65			4.96			5.05			5.11			5.21			5.33			5.32	

Community	2006			2007			2008			2009			2010			2011			2012			2013		
	Current	With NG	Reduction	Current	With NG	Reduction	Current	With NG	Reduction	Current	With NG	Reduction	Current	With NG	Reduction	Current	With NG	Reduction	Current	With NG	Reduction	Current	With NG	Reduction
Aklavik	7.1	4.83	2.27	7.27	4.94	2.33	7.42	5.04	2.37	7.57	5.15	2.42	7.73	5.26	2.47	7.94	5.4	2.54	8.11	5.52	2.6	8.29	5.64	2.65
Colville Lake	0.59	0.4	0.19	0.6	0.41	0.19	0.61	0.42	0.2	0.63	0.43	0.2	0.64	0.43	0.2	0.66	0.45	0.21	0.67	0.46	0.21	0.68	0.47	0.22
Deline	5.28	3.59	1.69	5.4	3.67	1.73	5.51	3.75	1.76	5.63	3.83	1.8	5.75	3.91	1.84	5.9	4.02	1.89	6.03	4.1	1.93	6.16	4.19	1.97
Fort Good Hope	4.82	3.28	1.54	4.93	3.36	1.58	5.04	3.42	1.61	5.14	3.5	1.65	5.25	3.57	1.68	5.39	3.67	1.73	5.51	3.75	1.76	5.63	3.83	1.8
Fort McPherson	3.67	2.5	1.17	3.76	2.55	1.2	3.83	2.61	1.23	3.92	2.66	1.25	4	2.72	1.28	4.11	2.79	1.31	4.19	2.85	1.34	4.29	2.91	1.37
Fort Simpson	17.28	11.75	5.53	17.69	12.03	5.66	18.05	12.28	5.78	18.44	12.54	5.9	18.83	12.8	6.02	19.34	13.15	6.19	19.75	13.43	6.32	20.18	13.72	6.46
Inuvik	87.82	59.72	28.1	89.91	61.14	28.77	91.76	62.4	29.36	93.73	63.73	29.99	95.69	65.07	30.62	98.28	66.83	31.45	100.37	68.25	32.12	102.58	69.76	32.83
Jean Marie River	0.55	0.37	0.18	0.56	0.38	0.18	0.57	0.39	0.18	0.59	0.4	0.19	0.6	0.41	0.19	0.61	0.42	0.2	0.63	0.43	0.2	0.64	0.44	0.21
Nahanni Butte	0.67	0.46	0.22	0.69	0.47	0.22	0.7	0.48	0.23	0.72	0.49	0.23	0.73	0.5	0.24	0.75	0.51	0.24	0.77	0.52	0.25	0.79	0.54	0.25
Trout Lake	0.52	0.36	0.17	0.54	0.36	0.17	0.55	0.37	0.18	0.56	0.38	0.18	0.57	0.39	0.18	0.59	0.4	0.19	0.6	0.41	0.19	0.61	0.42	0.2
Tsiigehtchic	1.56	1.06	0.5	1.59	1.08	0.51	1.63	1.11	0.52	1.66	1.13	0.53	1.7	1.15	0.54	1.74	1.18	0.56	1.78	1.21	0.57	1.82	1.24	0.58
Tuktoyaktuk	11.28	7.67	3.61	11.55	7.85	3.7	11.79	8.02	3.77	12.04	8.19	3.85	12.29	8.36	3.93	12.62	8.58	4.04	12.89	8.77	4.13	13.18	8.96	4.22
Tulita	3.83	2.61	1.23	3.93	2.67	1.26	4.01	2.72	1.28	4.09	2.78	1.31	4.18	2.84	1.34	0.29	2.92	1.37	4.38	2.98	1.4	4.48	3.05	1.43
Wrigley	1.56	1.05	0.5	1.59	1.08	0.51	1.62	1.1	0.52	1.65	1.12	0.53	1.69	1.15	0.54	1.73	1.18	0.55	1.77	1.2	0.57	1.81	1.23	0.58
Total	146.52	99.83	46.69	150.01	102.00	48.00	153.09	104.10	48.99	156.37	106.33	50.04	159.65	108.56	51.08	163.96	111.49	52.47	167.45	113.87	53.58	171.14	116.38	54.77
Forecast Overall Stationary Combustion Totals (kt CO_2)	716			731			746			762			778			799			816			834		
Natural Gas Requirement (m^3)		5.3e+07			5.4e+07			5.5e+07			5.6e+07			5.7e+07			5.9e+07			6.0e+07			6.2e+07	
Resulting Upstream Emissions (kt CO_2)		5.36			5.51			5.62			5.74			5.86			6.01 2			6.14			6.28	

Table 4: Potential Emissions Reductions with Natural Gas to Mackenzie Valley Communities

Year	Forecast Emissions (kt CO_2)	Potential Emissions Reduction (kt CO_2)	Forecast Emission with Natural Gas (kt CO_2)	Target Emission (kt CO_2)
1999	1429	42	1393	1044
2000	1473	43	1436	1044
2001	1491	44	1454	1044
2002	1505	45	1467	1044
2003	1525	46	1486	1044
2004	1547	46	1508	1044
2005	1538	46	1499	1044
2006	1553	47	1513	1044
2007	1575	48	1534	1044
2008	1622	49	1581	1044
2009	1647	50	1605	1044
2010	1672	51	1629	1044
2011	1698	52	1654	1044
2012	1725	54	1680	1044
2013	1746	55	1700	1044

Table 5: Cost of Conversion to Natural Gas

Community	Residences #	Local Lines $	Appliance Replacement $	Distance to Main Line km	Cost to Tie in to Main Line $	Commercial Building Cost $	Public Building Cost $	Power Generator Cost $	Total Cost $
Aklavik	218	$218,000	$763,000	60	$7,200,000	$1,066,047	$425,366	$150,000	$9,822,413
Colville Lake	22	$22,000	$77,000	130	$15,600,000	$0	$60,000	$100,000	$15,859,000
Deline	172	$172,000	$602,000	70	$8,400,000	$592,541	$236,685	$125,000	$10,128,226
Fort Good Hope	176	$176,000	$616,000	20	$2,400,000	$570,078	$225,900	$125,000	$4,112,978
Fort Liard	144	$144,000	$504,000	20	$2,400,000	$993,211	$251,448	$120,000	$4,412,659
Fort McPherson	264	$264,000	$924,000	100	$12,000,000	$811,711	$324,628	$150,000	$14,474,339
Fort Simpson	421	$421,000	$1,473,500	20	$2,400,000	$4,388,752	$1,752,803	$350,000	$10,786,055
Inuvik	1135	na	$3,972,500	na	na	na	na	na	$3,972,500
Jean Marie River	18	$18,000	$63,000	20	$2,400,000	$0	$60,000	$30,000	$2,571,000
Nahanni Butte*	24	$24,000	$84,000	90	$10,800,000	$0	$1,940,151	$30,000	$12,878,151
Trout Lake	24	$24,000	$84,000	60	$7,200,000	$0	$60,000	$30,000	$7,398,000
Tsiigetchic	49	$49,000	$171,500	80	$9,600,000	$199,987	$80,412	$60,000	$10,160,899
Tuktoyaktuk	254	$254,000	$889,000	130	$15,600,000	$2,570,294	$1,025,366	$150,000	$20,488,660
Tulita	129	$129,000	$451,500	20	$2,400,000	$595,972	$172,562	$115,000	$3,864,034
Wrigley	49	$49,000	$171,500	20	$2,400,000	$0	$60,000	$60,000	$2,740,500
Total									$133,669,414

Note: The cost of appliance replacement covers both hot water heaters and furnaces.

Table 6: Conversion of Industrial Operations to Natural Gas

	1999 to 2000			2000 to 2007			2008 to 2013		
Location	Current Emissions ($kt CO_2$)	Emissions With Natural Gas ($kt CO_2$)	Reduction ($kt CO_2$)	Current Emissions ($kt CO_2$)	Emissions With Natural Gas ($kt CO_2$)	Reduction ($kt CO_2$)	Current Emissions ($kt CO_2$)	Emissions With Natural Gas ($kt CO_2$)	Reduction ($kt CO_2$)
BHP	117.90	80.17	37.73	117.90	80.17	37.73	141.07	95.93	45.14
Diavik	0.00	0.00	0.00	154.41	105	49.41	154.41	105	49.41
Total	117.9	80.17	37.73	272.31	185.17	87.14	295.48	200.93	94.55
Natural Gas Requirement (m^3)		42400000			98000000			106300000	
Upstream Emisssions ($kt CO_2$)		4.33			9.99			10.84	

Table 7: Supply Hydro Power to Mining Development in the SGP

		1999 to 2000	2000 to 2007	2008 to 2013
	Current or Proposed Emissions ($kt\ CO_2$)	Potential Reduction ($kt\ CO_2$)	Potential Reduction ($kt\ CO_2$)	Potential Reduction ($kt\ CO_2$)
BHP	117.9 and 23.17	53	53	76.17
Diavik	154.41	0	69.48	69.48
Total		53	122.48	145.65

Table 8: Emissions Reduction Summary

Year	Current Emissions Forecast ($kt\ CO_2$)	Forecast Emission with Natural Gas ($kt\ CO_2$)	Forecast Emission with Hydro and Natural Gas ($kt\ CO_2$)	Target Emission ($kt\ CO_2$)
1999	1429	1366	1321	1044
2000	1473	1410	1366	1044
2001	1491	1384	1314	1044
2002	1505	1398	1327	1044
2003	1525	1417	1347	1044
2004	1547	1439	1368	1044
2005	1538	1430	1359	1044
2006	1553	1444	1374	1044
2007	1575	1466	1395	1044
2008	1622	1506	1418	1044
2009	1647	1530	1442	1044
2010	1672	1554	1467	1044
2011	1698	1579	1492	1044
2012	1725	1605	1518	1044
2013	1746	1626	1538	1044

Appendix D: Selected References

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